Volume 24, Number 3, February 15, 1970

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Division of Technical Information, Edward J. Brunenkant, Director,
Published by the USAEC Divison of Technical Information Extension, Robert L. Shannon, Extension Manager.

Nuclear Science Abstracts (NSA) provides the only comprehensive abstracting and indexing coverage of international nuclear science literature. *Nuclear Science Abstracts* covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author (issuing organization), and report number.

The following organizations scan and abstract the nuclear science literature in their respective countries:

Atomic Energy of Canada Limited
Australian Atomic Energy Commission
Danish Atomic Energy Commission
Finnish Atomic Energy Commission
French Atomic Energy Commission
Japan Atomic Energy Bureau-Atomic Energy Research Institute
Institutt for Atomenergi (Norway)
Aktiebolaget Atomenergi (Sweden)
United Kingdom Atomic Energy Authority

Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications, e.g., in the United States the American Institute of Physics provides page-proof copy of its publications.

A list of the journals scanned regularly and the abbreviations used appears in Issue 1 (January 15) of each volume of *Nuclear Science Abstracts* and is supplemented in Issues 7, 13, and 19. Issue 1 of each volume also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts,* available free from the USAEC Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

AVAILABILITY OF PUBLICATIONS ABSTRACTED

The latest public availability of all U. S. Atomic Energy Commission reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations abstracted in *Dissertation Abstracts* and included in *Nuclear Science Abstracts* are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan 48103.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USAEC Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830.

HOW TO OBTAIN NUCLEAR SCIENCE ABSTRACTS

Nuclear Science Abstracts is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

For the 24 regular issues, the yearly rate is $42.00 for domestic subscribers and $52.50 for foreign subscribers. A single issue costs $1.75, domestic rates, or $2.19, foreign rates. Domestic rates apply to the United States, Canada, Mexico, and Central and South American countries except Argentina, Brazil, Guyana, French Guiana, Surinam, and British Honduras.

For a yearly subscription to the cumulative indexes, the rates are $38.00 for domestic subscribers and $47.50 for foreign subscribers.

The following cumulative indexes are available:

From Johnson Reprint Corporation, 111 Fifth Avenue, New York, N. Y. 10003:
Vols. 1–4, Subjects and Authors (1948–1950), $30.00.

From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402:

Vols. 5–10, Subjects and Authors (1951–1956), $5.25.

Vols. 11–15, Subjects (1957–1961), $19.00.
Vols. 11–15, Personal Authors (1957–1961), $14.25.
Vols. 11–15, Corporate Authors (1957–1961), $2.50.

Vols. 16–20, Subjects (1962–1966), $36.00.
Vols. 16–20, Personal Authors (1962–1966), $22.50.
Vols. 16–20, Corporate Authors (1962–1966), $3.75.

Vol. 21, Subjects and Authors (1967), $16.00.
Vol. 22, Subjects and Authors (1968), $26.00.
Vol. 23, Subjects and Authors (1969) to be published.

Cumulative Report Number Index, Vols. 1-15 Revised, $4.00.
Cumulative Report Number Index, Vols. 16-20 Revised, $5.50.
Cumulative Report Number Index, Vols. 21-23 to be published.

Nuclear Science Abstracts is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Government agencies may obtain *NSA* free of charge. Inquiries should be directed to the USAEC Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830.

INDEXES TO NSA

Comprehensive indexes appear in each issue and are cumulated semiannually and annually. Multivolume cumulations have been issued as indicated above.

All documents abstracted are indexed by subjects and personal authors. Technical report literature is indexed also by corporate author and report number. Each of these indexes in every issue is preceded by an introduction explaining in detail the organization of the index and the principles by which it is compiled. The reader is referred to these explanations for information not found in the brief summary below.

Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T.
Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
ISHIHARA, Toyokuki
Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MEMBRANES
radiation effects on nuclear, in salivary gland cells of butterfly larvae, 23:50355
radiation effects on permeability of potassium ions througn, of mouse ascites carcinoma cells, electron and x, 23:50817
radiation effects on, in mitochondria of intestinal epithelial cells in mice, cobalt-60 γ, 23:50816
MENDELEVIUM
separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (**Los Alamos Scientific Lab., N. Mex.**). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
Fabrication of boron carbide rings and disks, 23:51093 (LA-4164)

Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

JPRS-	(Non-AEC)	
46949	23-51587	CFSTI
48330	23-52305	CFSTI
48331	23-52451	CFSTI
48481	23-50889	CFSTI
48743	23-51034	CFSTI
49025	23-51706	CFSTI (U. S. Sales Only)
JUL-	(German)	
571-RG	23-52269	Dep
578-PP	23-51624	Dep. CFSTI (U. S. Sales Only)
581-FN	23-51079	Dep. CFSTI (U. S. Sales Only)
584-RG	23-52313	Dep
586-FN	23-51035	Dep. CFSTI (U. S. Sales Only)
K-		
1777	23-50987	Dep. CFSTI
1778	23-50988	Dep. CFSTI
KFK-	(German)	
743	23-52461	Dep
743	23-52447	For translation see EURFNR-613
781/I	23-52462	Dep
824	23-52397	Dep. CFSTI (U. S. Sales Only)

TABLE OF CONTENTS

Volume 24, Number 3, February 15, 1970

Category *Page*

CHEMISTRY . . . 427
Analytical Chemistry . . . 427
Chemical and Spectral Procedures . . . 427
Radiometric Procedures . . . 430
Activation Procedures . . . 431
Inorganic, Organic, and Physical Chemistry . . . 433
Radiation and Nuclear Chemistry . . . 437
Separation Processes . . . 442

EARTH SCIENCES . . . 445
Geology and Hydrology . . . 445
Meteorology . . . 446
Mineralogy and Exploration . . . 447

ENGINEERING . . . 448
Nuclear Explosions . . . 448
Facilities and Equipment . . . 448
Heat Transfer and Fluid Flow . . . 449
Isotope Technology . . . 449
Materials Testing . . . 450
Radioactive Material Handling . . . 450

INSTRUMENTATION . . . 451
Radiation Detection Instruments . . . 451
General Detectors and Monitors . . . 451
Nuclear Spectroscopic Instrumentation . . . 454
High Energy Physics Instrumentation . . . 456
Radiation Dosimeters . . . 457
Radiometric Instruments . . . 457
Miscellaneous Instruments and Components . . . 457
Radiation Effects on Instruments and Instrument Components . . . 460

LIFE SCIENCES . . . 462
Biochemistry, Physiology, and Molecular Biology . . . 462
Basic Processes . . . 462
Metabolism, Physiology, and Toxicology . . . 462
Radiation Effects . . . 464
Immunology . . . 466
Ecology . . . 468
Genetics and Cytogenetics . . . 469
Health Physics and Safety . . . 471
Radioactive Contamination and Decontamination . . . 471
Dosimetry and Monitoring . . . 471
Radiation Protection . . . 473
Safety Procedures . . . 473
Legal Aspects . . . 473
Medicine . . . 474
Protective Substances . . . 474
Radiation Sickness and Injuries . . . 474
Radiodiagnosis . . . 475
Radiotherapy . . . 476
Radiation Effects on Animals . . . 477
Invertebrates . . . 478

Category *Page*

LIFE SCIENCES (Cont'd.)
Vertebrates . . . 479
Man . . . 480
Radiation Effects on Plants . . . 481
Radiation Effects on Microorganisms . . . 481
Radiosterilization and Radiopreservation . . . 481

METALS, CERAMICS, AND OTHER MATERIALS . . . 483
Metals and Alloys . . . 483
Corrosion and Erosion . . . 483
Preparation and Fabrication . . . 486
Properties Evaluations . . . 490
Structure and Phase Studies . . . 495
Radiation Effects . . . 496
Ceramics and Cermets . . . 497
Corrosion and Erosion . . . 497
Preparation and Fabrication . . . 497
Properties Evaluations . . . 499
Structure and Phase Studies . . . 500
Radiation Effects . . . 501
Plastics and Other Materials . . . 502

PHYSICS (GENERAL) . . . 503
Astrophysics and Cosmology . . . 503
Cosmic Ray Exposure Ages . . . 503
Stars . . . 503
Quasi-Stellar, Radio, and X-Ray Sources . . . 507
Solar Phenomena . . . 510
Galaxies . . . 511
Cosmology . . . 513
Planetary Phenomena . . . 514
Atomic and Molecular Physics . . . 514
Atomic, Electron, Ion, and Molecular Beams and Their Reactions . . . 514
Atomic and Molecular Properties . . . 514
Collision Phenomena . . . 515
Atomic Theory . . . 516
Cosmic Radiation . . . 516
Direct Energy Conversion . . . 518
Fluid Physics . . . 518
Geophysics (Upper Atmosphere) . . . 519
Low-Temperature Physics . . . 526
Plasma and Thermonuclear Physics . . . 531
Confinement and Heating . . . 531
Diagnostics . . . 531
Kinetics (General) . . . 532
Kinetics (Experimental) . . . 532
Kinetics (Theoretical) . . . 533
Production . . . 534
Stability . . . 534
Thermonuclear Processes . . . 534
Wave Phenomena . . . 535
Shielding . . . 536

TABLE OF CONTENTS (continued)

Category *Page*

PHYSICS (GENERAL) (Cont'd.)
- Solid-State Physics 537
  - *Radiation Effects* 537
  - *Physical Properties* 538
  - *Moessbauer Effects and NMR* 538
  - *Theory* 539
- Theoretical Physics 539

PHYSICS (HIGH-ENERGY) 540
- Particle Interactions and Properties (Experimental) 540
  - *Electromagnetic* 540
  - *Weak* 540
  - *Strong (Baryon-Induced)* 540
  - *Strong (Meson-Induced)* 541
- Particle Interactions and Properties (Theoretical) 542
  - *General* 542
  - *Electromagnetic* 542
  - *Weak* 543
  - *Strong (General)* 544
  - *Strong (Baryon No. = 0)* 544
  - *Strong (Baryon No. = 1)* 545
  - *Strong (Baryon No. ⩾ 2)* 547
- Particle Invariance Principles and Symmetries 547
  - *General* 547
  - *Applications (Electromagnetic and Weak)* 547
  - *Applications (Strong)* 547
- Field Theories 548
  - *Quantum Field Theory* 548
  - *Gravitation and General Relativity* 549
- Scattering Theory 549
- Particle Accelerators 550

PHYSICS (NUCLEAR) 553
- Neutron Interactions with Matter 553
- Nuclear Properties and Reactions, $A \leq 5$ 553

Category *Page*

PHYSICS (NUCLEAR) (Cont'd.)
- Nuclear Properties and Reactions, $6 \leq A \leq 19$ 553
- Nuclear Properties and Reactions, $20 \leq A \leq 89$ 555
- Nuclear Properties and Reactions, $A \geq 90$ 556
- Nuclear Theory 558

REACTOR TECHNOLOGY 562
- Commercial Power Reactors 562
- Power Reactor Development 564
  - *Kinetics and Dynamics* 565
  - *Cooling Systems* 565
  - *Fuels* 566
  - *Operation and Economics* 566
  - *Safety and Siting* 566
- Research and Test Reactors 567
- Rocket and Space Reactors 568
- Process Heat and Desalination Reactors 569
- Reactor Theory 569
  - *Kinetics* 569
  - *Dynamics* 570
  - *Experimental Applications* 570
- Reactor Components, Fuels, and Accessories 570

GENERAL 572

CORPORATE AUTHOR INDEX INDEX-1

PERSONAL AUTHOR INDEX INDEX-7

SUBJECT INDEX INDEX-44

REPORT NUMBER INDEX INDEX-101

STAFF OF NUCLEAR SCIENCE ABSTRACTS

John W. Norris
Managing Editor

Donald D. Davis
Assistant Managing Editor

David E. Bost
Production Manager

Sidney F. Lanier
Subject Heading Specialist

J. Paul Meredith
Descriptive Cataloging Specialist

Frederick E. Marsh, Jr.
Computer Index Coordinator

Clara L. Fox
Corporate Author Specialist

Helen W. White
Report Number Specialist

Section Editors

Everett J. Hoffman
Chemistry

Robert C. Kelly
Engineering; Earth Sciences; Metals, Ceramics, and Other Materials

Lee M. Thompson
General Physics

Charles E. Stuber
High Energy Physics; Instrumentation

Helen G. Donald
Life Sciences

Lawrence T. Whitehead
Nuclear Physics

James M. Jacobs
Reactor Technology

Evaluators

Thomas S. Chapman
Rose V. Jermain
John H. Mitchell
Mary H. Newman
Polly C. Summers

Abstractors

F. S. Armstrong*
Ellis R. Bedford
Mary M. Brown
Jane G. Buchanan
D. Lamar Cason
Gloria M. Caton
David C. Cunningham
James R. Dulaney
Helga B. Gerstner
Mary C. Grissom
Phyllis C. Hansen
Carolyn D. Houston
Rose V. Jermain
W. Hugh Kinser, Jr.
Lisbeth C. Lieberman
Betty L. McDowell
Fay M. Martin
William D. Matheny
Dora H. Moneyhun
Carol Oen
Jean F. Peckham
Henry D. Raleigh
Mona H. Raridon
Julia S. Redford
Jessie W. Rushing
Francis L. Sachs
Lila B. Smith
Myrna L. Steele
Anne G. Ward
Helen L. Ward
Milton O. Whitson
Juanita Wilson

---

*Atomic Energy of Canada, Ltd.

Communication concerning the editorial policy and content of *Nuclear Science Abstracts* should be addressed to the Managing Editor, *Nuclear Science Abstracts*, USAEC Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 26, 1969.

TABLE OF CONTENTS (continued)

[illegible]

Volume 24, Number 3 February 15, 1970

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Chemical and Spectral Procedures

Refer also to abstracts 4411, 4430, 4711, 4714, and 5205.

4196 (CEA-R-3911) PRODUCTION OF URANIUM STANDARD SAMPLES FOR SPECTROGRAPHIC ANALYSIS. Neuilly, Michele; Leclerc, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct 1969. 30p. (In French). Dep. CFSTI (U. S. Sales Only).

The conditions of preparation of twelve castings of uranium intended for use as reference samples in spectrographic analysis are described. Results are given of impurity determinations carried out by several laboratories using different methods, together with the "probable values" of the concentrations. Samples of these different castings are now available and can be sent to any laboratory which requires them. (auth)

4197 (NRL-6948) PROCEDURES FOR THE ANALYSIS OF METALS, ALLOYS, AND OTHER MATERIALS OF RESEARCH. PART 4. SPECTROPHOTOMETRIC PROCEDURES FOR THE DETERMINATION OF IONS FORMED WITHIN STRESS-CORROSION CRACKS. Gates, O. R. (Naval Research Lab., Washington, D. C.). 7 Oct 1969. 12p.

Working at final volume levels as low as 3 ml, spectrophotometric procedures were developed for the determination of very small amounts of ferrous, ferric, and alloying-constituent ions formed within stress-corrosion cracks in carbon steels and in steels containing nickel, chromium, molybdenum, and manganese, respectively. (auth)

4198 ATOMIC-EMISSION SPECTROSCOPY OF THE RARE EARTH ELEMENTS IN A SEPARATED NITROUS OXIDE-ACETYLENE FLAME. Hingle, D. N.; Kirkbright, G. F.; West, T. S. (Imperial Coll. of Science and Tech., London). Analyst; 94: 864-70(Oct 1969).

Flame emission in the interconal zone of a separated nitrous oxide–acetylene flame was shown to provide a sensitive technique for the detection of the rare earth elements, scandium, and yttrium. The relative intensities of the principal atomic lines of these elements emitted in this flame were measured, and the detection limits at the lines most suitable for flame-emission spectroscopy are reported for aqueous and ethanolic sample solutions. The effect on the atomic-emission intensities obtained for each of the sixteen elements investigated in the presence of the other fifteen elements was investigated. At the concentrations used in this general survey no serious spectral line interferences between the rare earths were observed, because of the simple spectra excited by the hot, reducing fuel-rich flame. (auth) (UK)

4199 CONTROLLED-POTENTIAL COULOMETERS BASED UPON MODULAR ELECTRONIC UNITS. PART II. THE DETERMINATION OF RUTHENIUM BY CONTROLLED-POTENTIAL COULOMETRY. Weldrick, G.; Phillips, G.; Milner, G. W. C. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst; 94: 840-3(Oct 1969).

In the method described quadrivalent ruthenium as the binuclear $[Ru_2O]^{6+}$ chlorocomplex in $5\underline{M}$ hydrochloric acid is reduced to tervalent ruthenium at the platinum electrode at a potential of +0.05 V versus the S.C.E. Milligram amounts of ruthenium can be determined with a coefficient of variation of 1.0%. The method was applied to uranium–ruthenium alloys and uranium carbide–ruthenium cermet materials. (auth) (UK)

4200 ATOMIC-ABSORPTION DETERMINATION OF STRONTIUM IN A STANDARD PLANT MATERIAL: COMMENT ON RESULTS OF INTER-LABORATORY COMPARISON. David, D. J. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Analyst; 94: 884-5(Oct 1969).

The concentration of strontium in Bowen's standard kale was found to be 101.13 ± 2.38 ppM, on evidence that x-ray fluorescence values obtained subsequently to Bowen's inter-laboratory comparison were in good agreement at 101 ppM with atomic absorption values by using anion exchange and the addition method. Methods used in obtaining neutron-activation results and the other atomic-absorption results implied in the inter-laboratory comparison should be examined for serious interferences. (auth) (UK)

4201 METAL COMPLEXES WITH TROPOLONES. Dutt, Y. (Univ. of Delhi); Sing, R. P.; Katyal, M. Talanta; 16: 1369-82(Oct 1969).

Analytical applications of tropolone and its derivatives are reviewed. The most recent work in the chemistry of the tropolones is in the field of mixed complexes with various β-diketones and other donor molecules, particularly in connection with solvent extraction techniques. (UK)

4202 POTENTIOMETRIC DETERMINATION OF PLUTONIUM IN NITRIC ACID MEDIUM. Emura, Satoru; Okazaki, Shuji (Japan Atomic Energy Research Inst., Tokai). Bunseki Kagaku, 18: 1264-5(Oct. 1969). (In Japanese).

An accurate method is described for the determination of Pu in HNO_3 solutions by direct reduction of the Pu in mixtures of HNO_3, H_2SO_4, and sulfamic acids with a stannous chloride solution and titration with a standard solution of $Ce(SO_4)_2$. The titration curve is recorded by an automatic recording titrator with a combined electrode of Pt–Ag–AgCl. Over the range from 5 to 15 mg of Pu, the coefficient of variation was 0.5 to 0.25% for the accountability analysis of Pu in the reprocessing of irradiated fuel. (NSA of Japan)

4203 DETERMINATION OF CALCIUM, STRONTIUM, BARIUM, AND YTTRIUM BY SPECTROPOLARIMETRIC ANALYSIS. Palma, R. J. Sr.; Reinbold, P. E.; Pearson, K. H. (Texas A and M Univ., College Station). Anal. Lett.; 2: 553-64(Oct 1969).

A spectropolarimetric method of analysis was developed for calcium(II), strontium(II), barium(II), and yttrium(III) utilizing the stereospecific ligand, D-(-)-1,2-propylenediaminetetraacetic acid (D(-)PDTA). The optical rotation of the solution was monitored with a photoelectric polarimeter to determine the end point of the titration. The metal complexes and titrant are optically active and serve as self-indicators. Since D(-)PDTA is stereospecific in its reaction with these metals, maximum utilization of the optical rotation of these complexes is achieved. The observed optical rotation is linear with respect to concentration of the metal complexes; consequently, it is possible to perform straight line extrapolations to the end point. The effects of some parameters were investigated and optimum conditions were established. The range of the average deviations from visual chelometry for the four metals determined was 0.00 to 0.50%. (auth)

4204 SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN NUCLEAR GRAPHITE SYSTEM. Kleinmann, I.; Vockova,

J. (Inst. for Research, Use, and Production of Radioisotopes, Prague). Jad. Energ; 15: 384-8(1969). (In Czech).

The dependence of intensity and reproducibility of the spectral lines of B, Cd, Ge, Eu, Dy, Sm, Al, Fe, Mn, and Si on the discharge current, amount of NaF carrier, chemical form of impurities with different boiling points, and on the electrode distance in the spectrographic analysis of pure graphite was experimentally determined. It was proved that the use of lines of internal comparative elements, having not sufficiently high correlation coefficients with the analytical lines may lead to a decreased reproducibility of results. (auth)

4205 DETERMINATION OF NIOBIUM IN IRON AND STEEL BY THE EXTRACTION SPECTROPHOTOMETRIC METHOD. Sakaki, Takashi (Japan Special Steel Co., Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 33: 1092-8(Sept. 1969). (In Japanese).

An extraction spectrophotometric method with sulfochlorophenol S for the determination of niobium was investigated, and applied to the determination of niobium in iron and steel. The niobium sulfochlorophenol S complex is formed quantitatively in 1.2 to 2.4$\underline{N}$ hydrochloric acid media and this complex is quantitatively and easily extracted with n-butyl alcohol in the presence of diphenylguanidine. The absorption maximum of the extracted complex is at a wavelength of 650 millimicrons. Iron, molybdenum, and zirconium interfere with the determination of niobium, but these interferences can be eliminated to some extent by the use of thioglycolic acid and EDTA. The presence of sulfates of chromium and nickel lowers the absorbance for the determination of niobium; the coexistence of more than 2 mg each of chromium and nickel and of more than 0.5 mg of chromium and 1 mg of nickel interferes with the determination of 10γ and 20γ of niobium, respectively. The addition of more than 0.5 ml of sulfuric acid (1 + 10) in the presence of 0.5 ml of phosphoric acid (1 + 10), lowers the absorbance for the determination of 20γ of niobium. The sample was fumed with a mixture of sulfuric and phosphoric acids for dissolving completely the carbides and tungstic acid after the sample was dissolved in aqua regia. A method in which 0.01 to 2% niobium contained in iron and steel can be measured precisely without difficulty was developed from the results. (auth)

4206 SIMPLE TWO CRYSTAL SPECTROMETER AND ITS APPLICATION TO X-RAY SPECTROCHEMICAL ANALYSIS. Gohshi, Y. (Toshiba Central Research Lab., Kawasaki, Japan). Advan. X-Ray Anal., 12: 518-33(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

A simple two-crystal spectrometer was constructed, making use of a commercial one-crystal spectrometer. A detector attached to a 2θ-arm was replaced by a second crystal. The detector is placed at an appropriate position apart from the 2θ-arm. The spectrometer is operated as if it were a one-crystal spectrometer. The dispersion of the spectrometer in this mode of operation is the sum of those of the first and second crystals. Ge(220) crystals gave the best resolution which was about 3.3 eV fwhm for Cu $K_{\alpha 1}$. The strongest intensity was observed using etched LiF crystals. The intensity was about $\frac{1}{4}$ of that of a one-crystal spectrometer and the resolution was about 9.5 eV fwhm for Cu $K_{\alpha 1}$. The spectrometer was applied to the determination of hafnium in zirconium and Zircaloy. The Zr K_α 2nd order line, which coincides with the Hf $L_{\alpha 1}$ line, was completely eliminated by successive reflections by Ge(111) crystals owing to the extinction rule and the high resolving power. The detection limit was about 7 ppM of hafnium. Another example is the separation of the As $K_{\alpha 2}$ line from the Pb $L_{\alpha 1}$ line. Arsenic in low alloy steel was determined without the correction for the well known interference of lead. The very common interference of Cr K_β on Mn K_α was also eliminated completely by this spectrometer. Though the spectrometer is not very suitable for a wide wavelength range spectroscopic measurement, owing to its narrow window region (about ±1°), the chemical effects on K_β spectra of sulfur in various compounds were investigated. Fine structures were found in the sulfur K_β spectra of several thiocyanates and elemental sulfur. To observe long wavelength spectra, the x-ray path of the spectrometer was modified. (auth)

4207 A RAPID AND ACCURATE X-RAY DETERMINATION OF THE RARE EARTHS ELEMENTS IN SOLID OR LIQUID MATERIALS USING THE DOUBLE DILUTION METHOD. Tertian, R. (Societe de Produits Chimiques, Pechiney-Saint Gobain, France). Advan. X-Ray Anal., 12: 546-62(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

The procedure has been tested successfully for accurate determination of rare earth elements using, for solid materials such as ores and oxide mixtures, the borax fusion technique. It also can be readily applied to liquids. All the rare earth elements can be titrated by that method, as well as yttrium, thorium and, if necessary, all the elements relevant to x-ray fluorescence analysis. The concentration range considered for solids is of one comprised between 0.5 and 100% and, with a lesser accuracy, between 0.1 and 0.5%. Examples are given relative to the analysis of various ores. Finally it must be pointed out that the method is universal and applies to the analysis of every solid, especially ores, provided that they can be converted to solid or liquid solutions. It appears that most industrial analyses can be worked on in this way. (P.C.H.)

4208 MASS ABSORPTION COEFFICIENTS AND QUANTITATIVE MICROANALYSIS OF REFRACTORY METAL CARBIDES. Gray, Lawrence J.; Wert, C. A. (Univ. of Illinois, Urbana). Advan. X-Ray Anal., 12: 563-80(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Consideration of variations in atomic potentials permits an estimation of the mass absorption coefficients of many elements for the characteristic emission lines of carbon, nitrogen, and oxygen. The accuracy of (μ/ρ) values presented is better than 5% in most cases. These values were tested in the microanalysis of defect titanium carbides. Limitations of the theoretical correction procedures led to the definition of a set of analysis conditions which permit carbon analysis to within 1.0% absolute. (auth)

4209 ADVANCES IN X-RAY ANALYSIS. VOLUME 12. Proceedings of the Seventeenth Annual Conference on Applications of X-Ray Analysis Held August 21–23, 1968, Estes Park, Colorado. Barrett, Charles S.; Newkirk, John B.; Mallet, Gavin R. (eds.). New York, Plenum Press, 1969. 656p. $22.50. (CONF-680841).

Forty papers are included; separate abstracts were prepared for 13. The remaining 27 papers contain information on: crystallography and diffraction; methods and their applications; strain analysis, crystalline fine structure, fluorescence and texture analysis, and x-ray spectrochemical analysis. (P.C.H.)

For abstracts of individual papers see: 4206–4208, 4411, 4746, 4789–4791, 4808, 4809, 4845, 4864, and 5205.

4210 OXYGEN DETERMINATION IN CARBIDE AND OXIDE COMPOUNDS OF URANIUM AS WELL AS IN METAL CARBIDES STABLE AT HIGH TEMPERATURE. Nickel, H.; Rottmann, J. (Kernforschungsanlage, Juelich, Ger.). pp 1057-78 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The oxygen determination in powdered uranium carbides and carbides of the transitions metals of the IVa, Va, and VIa groups was tested by a bath-free nitrogen hot extraction method. The utility of the new method was considered in comparison with the vacuum hot extraction method and the argon carrier gas method. For investigation of the reaction mechanism of the degassing, both thermodynamic calculations and also chemical, x-ray diffraction, and metallographic studies were made on the degassed samples at 2000° or 1500°C in nitrogen current. In the nitrogen decomposition in the carbides of U, Ti, Zr, and Hf the nitrogen plays a role not only as a carrier gas but also contributes by the formation of stable carbon nitride to the fast and complete degassing. Moreover it permeates, in contrast to argon, compact analysis material because of its favorable diffusion rate with a number of microcracks, through which the CO formed in the oxygen reduction was transported from the reaction zone. The new analysis method is also suitable to the determination of oxygen impurities in the carbides of the elements of the Va and VIa groups. The advantages of the N_2 carrier method over other hot extraction methods are discussed. (tr-auth)

4211 DETERMINATION OF OXYGEN, NITROGEN, AND HYDROGEN IN HIGH-MELTING METALS. Friedrich, K. (Institut fuer Metallphysik und Reinstmetalle, Dresden); Lassner, E.; Kraus, T.; Paesold, G.; Schlaet, F. pp 1016-27 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

After systematic comparison studies of compact niobium and tantalum samples with known contents of nitrogen and oxygen and on powders used for vacuum degassing, the following methods were found useful. For oxygen determination in niobium and tantalum powders the Pt flux method is the most suitable. The diffusion extraction at 2150 or 2300°C can be developed for oxygen determination in compact niobium and tantalum samples. The melt degassing at 2300°C and also the Mo flux technique allows oxygen determination in niobium, but not in tantalum. Since none of the techniques studied yield completely satisfactory nitrogen results, it is necessary to use an empirical factor (Pt flux or bath, Ni−Ce−Mg technique), when determining nitrogen in niobium and tantalum by the vacuum degassing method. (tr-auth)

4212 NITROGEN DETERMINATION IN HIGH-MELTING NITRIDES. Schneider, H.; Hein, W. pp 1028-30 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The Kjeldahl method using $HF-H_2O_2$ or HF at 200°C under pressure and a vacuum hot extraction method were compared for the determination of nitrogen in the nitrides NbN, TaN I, TaN II, TiN, and ZrN. Very good agreement was obtained between the two methods. (J.S.R.)

4213 REPRODUCIBILITY OF GAS DETERMINATION IN METALS. Lassner, E.; Pueschel, R. pp 1031-3 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The accuracy of the gas determinations in metals using the hot extraction method was analyzed. It was established that the hot extraction at least yields results with as good or in many cases better reproducibility than that obtained by other chemical methods. The reproducibility to be expected in each case is dependent on the instruments used and on the method, on the sample material, and the gas to be determined. Gas contents under 1 ppM can be determined only in special cases and with special precautions. (tr-auth)

4214 DETERMINATION OF THE NITROGEN CONTENT OF URANIUM MONONITRIDE BY ALKALINE FUSION AND AMMONIA DISTILLATION. Greenhalgh, W. O. (Battelle-Northwest, Richland, Wash.). Analyst; 94: 1050-2(Nov 1969).

A fusion procedure for determining the nitrogen content of uranium mononitride materials was developed. Recovery of 96.7% of theoretical nitrogen was demonstrated with a sodium hydroxide melt containing 20 wt % of sodium carbonate at a fusion temperature of 500 to 525°C. The uranium mononitride reference sample used contained 600 ppM of oxygen, 200 ppM of carbon and less than 500 ppM of halide impurities. Fifteen analyses of a stoichiometric mononitride reference sample gave a nitrogen content of 5.37 wt %, average deviation of ±0.04 and standard deviation of ±0.06. Analyses of ammonium iron(III) sulphate and ammonium chloride for nitrogen by the alkaline fusion technique gave nitrogen recoveries of 98.9 and 100.5%, respectively. Fusions carried out at temperatures below 475°C were not completely digested. Fusion analyses at temperatures above 575°C gave slightly lower nitrogen values because of partial decomposition of the ammonia. (auth)

4215 EXTRACTION-PHOTOMETRIC DETERMINATION OF URANIUM AND RHENIUM UPON COMBINED PRESENCE. Sokolova, L. S.; Kovalenko, P. N.; Shchemeleva, G. G. (Rostov State Univ., Rostov-on-Don, USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 12: 875-80(1969). (In Russian).

A combined photocolorimetric method was developed for the determination of uranium and rhenium in the form of ternary compounds with crystal violet and sodium benzoate. The composition and structure of the compounds formed were studied by absorption and infrared spectroscopy. The composition of the colored products of the reaction corresponds to the following formulas, where K is the dye cation: $K^+[UO_2(C_6H_5COO)_3]^-$; $K_2(ReO_4^-)(C_6H_5COO^-)$. Uranium and rhenium were determined in metallic lead. (auth)

4216 DIRECT COMPLEXOMETRIC DETERMINATION OF MAGNESIUM IN THE PRESENCE OF URANIUM, IRON, AND ALUMINUM. Mareska, V. (Nuclear Research Inst., Rez, Czech.). Talanta; 16: 1486-8(Nov 1969).

The method described is based on the marking of U by hydroxylamine, and of Fe and Al by triethanolamine. Methylthymol blue is used as indicator for the EDTA titration of Mg at pH 10. (auth)

4217 POTASSIUM AND ^{137}Cs DESORPTION FROM SOILS. Benes, J. (Inst. of Nuclear Research, Prague); Panyr, M. Jad. Energ.; 15: 299-302(Sep 1969). (In Czech).

The 11 methods recommended for potassium extract preparation from soils were compared and the results used in ^{137}Cs desorption. The desorption effects of hydrochloric acid and ammonium acetate for ^{137}Cs were compared in relation to the ratio of extracting agent to soil. The conditions for ^{137}Cs and K determinations in soils are discussed. (auth)

4218 SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN U_3O_8 POWDER BY THE EXCITATION IN HIGH-DENSITY ARGON DISCHARGE. Kleinmann, Imrich; Svoboda, Vratislav (Inst. of Research, Production, and Application of Radioisotopes, Prague). Jad. Energ.; 15: 295-8(Sep 1969). (In Czech).

A spectrographic method was developed for determination of impurities in U_3O_8 in a 60-A dc arc in an argon atmosphere. The conditions for the optimum excitation of spectral lines of the impurities were investigated. The results were compared with commonly used methods. (auth)

4219 ATTI DEL XIV SEMINARIO SPETTROCHIMICO, MONTECATINI, [ITALY], 3–6 OTTOBRE 1968. (Proceedings of the Fourteenth Spectrochemical Seminar, Montecatini, Italy, October 3–6, 1968). Met. Ital.; 61: 337-423(Aug 1969). (CONF-681070).

Eighteen papers were presented at the Fourteenth Spectrochemical Seminar. Separate abstracts were prepared for two of the papers. (D.H.M.)

For abstracts of individual papers see: 4220 and 4221.

4220 DETERMINATION OF TRACES OF YTTERBIUM IN RARE EARTHS BY MEANS OF ATOMIC ABSORPTION WITH RADIOFREQUENCY PLASMA. Bordonali, C. (CNEN, Rome); Biancifiori, M. A.; Donato, A. Met. Ital.; 61: 360-4(Aug 1969). (In Italian).

From 14th Spectrochemical Seminar, Montecatini, Italy. See CONF-681070).

The determination of traces of ytterbium is carried out in concentrated nitric solutions, containing up to 4% of the weight of various elements such as lanthanum, europium, cerium, aluminum, samarium, calcium, magnesium, etc. An induced plasma in argon atmosphere is used: the various operative parameters are optimized; the depressing interferences caused by the elements are analysed at various concentrations of the interfering element (also present, although in a very modest quantity, in the atomic absorption with plasma). Some methods for reducing the interference to an acceptable level are suggested. The sensibility obtained is of the order of a few ppM with respect to the initial solution). (auth)

4221 SPECTROGRAPHIC ANALYSIS OF TANTALUM IN SMALL CONCENTRATIONS IN ZIRCONIUM MATRICES. De Gregorio, P. (Centro Sperimentale Metallurgico, Rome); Rossi, G. Met. Ital.; 61: 374-8(Aug 1969). (In Italian).

From 14th Spectrochemical Seminar, Montecatini, Italy. See CONF-681070.

A spectrographic method for the determination of traces of tantalum in zirconium and Zircaloy-2, is presented. A fast evaporation of the impurity in the arc column is achieved through a fluorination process of the sample during the discharge. Depending on the matrix to be analyzed 3 to 4% of polytetrafluoroethylene powder as fluorine supply is added to the samples excited by a Stallwood Jet stabilized dc arc with argon/oxygen atmosphere. A linear relationship is established between the tantalum concentration is the range 25 to 500 ppM and the intensities ratios I_{Ta} 2653.27/I_{Zr} 2658.69 and I_{Ta} 2653.27/I_{Zr} 2658.68 for the zirconium and Zircaloy-2 respectively. A mean error of about 10% was evaluated on the mean of five arcing on each sample in both cases. (auth)

4222 THE FALLING DROP METHOD FOR DEUTERIUM OXIDE: FACTORS INFLUENCING ACCURACY. Clarke, Miriam F. (Woman's Medical Coll. of Pennsylvania, Philadelphia). Anal. Biochem.; 31: 81-90(1 Oct 1969).

Factors affecting the accuracy of the falling drop method for D_2O were considered: selection of temperature of the constant-temperature bath, permissible temperature fluctuations, and D_2O concentration. Bath temperatures used, 27.24 to 27.32°C, and constancy within ±0.02° had no influence on the regression relating drop velocity to concentration, $v = a + bc$, or sampling error ($S.D._v$). The latter increases significantly with concentration from 0.05 to 0.23 ml % D_2O, is significantly smaller than experimental error ($S.D._e$), and is inappropriate for estimating intra-assay limits. More appropriate is the $S.D._c$ derived from the variance of the terms of the regression equation. Assay results using this error term can be expected to vary from about ±4.8% at 0.05 ml % to about ±2% at 0.23 ml %. These results compare favorably with those reported for the mass spectrograph used to determine the mass ratio of HDO/H_2O vapor. A more conservative estimate is obtained by using $\lambda = S.D._e/b$, which in this work indicated within-assay variability of ±12.4% at 0.05 ml % and ±2.7% at 0.23 ml % D_2O. The term $S.D._e$, corresponding to 0.0062 ml % in these experiments, provides the best means for assay comparisons. Satisfactory recoveries of D_2O added to urine averaging 99% of known values were obtained after shell-freezing, without distillation of standards and without permanganate oxidation of samples. No increase in error beyond that anticipated from standards alone was observed when urine was the vehicle. (auth)

4223 THE USE OF LANDOLT REACTIONS IN QUANTITATIVE MICROANALYSIS. IV. QUANTITATIVE DETERMINATION OF IRON AND MOLYBDENUM. Thompson, H.; Svehla, G.

(Queen's Univ., Belfast). Z. Anal. Chem.; 247: 244-8(30 Oct 1969).

Trace amounts of iron(III) and molybdenum can be determined by their catalytic effect on the perborate-iodide reaction transformed to a Landolt process. Calibration graphs for the 1 to 10 μg/ml concentration range for each are presented and the reproducibility of the methods is given on a statistical basis. The effects of about thirty ions and complexing agents are reported and suggestions are made regarding the possibility of using EDTA and tartrate to enable iron and molybdenum to be determined separately in a mixture. Anomalous behaviour of osmium(VIII) is reported. (auth)

4224 INVESTIGATIONS ON PRECIPITATION REACTIONS FOR THE ENRICHMENT OF TRACE ELEMENTS. IV. DETERMINATION OF PALLADIUM IN PURE METALS AFTER HIGHLY SELECTIVE ENRICHMENT ON SILVER CYANIDE. Jackwerth, E.; Graffmann, G.; Lohmar, J. (Institut fuer Spektrochemie und Angewandte Spektroskopie, Dortmund, Ger.). Z. Anal. Chem.; 247: 149-54(30 Oct 1969). (In German).

Systematic investigations on the sorption of palladium on different insoluble silver compounds showed that silver cyanide is a suitable trace catcher for the highly selective enrichment of palladium. Even with a 10^7- to 10^9-fold excess of Fe, Co, Ni, Mn, Cu, Ag, Zn, Cd, Al, Tl, Sn, Pb, Bi, Th, and U the co-precipitation of traces of palladium is not influenced. Based on this observation a method was developed for the analysis of Ni, Cu, and Ag. The Pd co-precipitated with AgCN was determined photometrically and by a spectrographic method. Samples containing 6×10^{-7}% of Pd could be analyzed with a relative standard deviation between 4 and 16%. The statistical limit of detection is about 10^{-7}% of Pd. (auth)

4225 ANALYTICAL INVESTIGATION OF PURE AND ADDITIVE CONTAINING MONOCARBIDES OF URANIUM. Lievens, F.; Lecocq, A.; Constant, M. (CEN, Mol, Belgium). Z. Anal. Chem.; 247: 171-5(30 Oct 1969). (In French).

The techniques of sampling and the analytical methods are described in detail. These methods take into account the extreme sensitivity of carbides to atmospheric agents and also changes in structure or composition. The stoichiometric composition was verified by a gravimetric determination of carbon with a relative error below 0.1%. Traces of oxygen and nitrogen were determined by fusion under a stream of helium and by the Kjeldahl method, respectively. Volumetric redox methods are employed for the determination of stabilizing additives (Cr, V). (auth)

4226 ON A DIRECT DETERMINATION OF TRACES IN HIGHLY PURIFIED GRAPHITES BY EMISSION-SPECTROCHEMICAL ANALYSIS USING MAGNETIC FIELDS. Nickel, H.; Leushacke, D. F.; Lummerzheim, D. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem.; 247: 196-208(30 Oct 1969). (In German).

The application of a homogeneous magnetic field for emission-spectrochemical analysis results in an increase by about one order of magnitude of analytical sensitivity, which permits a direct determination of the elements vanadium, titanium, boron, and silicon in highly purified graphites. During burning of the magnetized dc arc the behaviour of the analized graphite was examined with regard to arc voltage, anode temperature, and burnup. Because of the low relative standard deviation of the $I_L - I_U$-ratios and the background density the best results were obtained by a magnetic induction of 300 G. In general the amplification was stronger at an arc current of 15 A than at 10 A. Moreover, at 15 A, a higher burnup of the anode was obtained. Generally speaking the advantage of working with longitudinal magnetic fields lies in an increased line intensity as well as in a background reduction in spite of the higher burnup. That leads to an increase of the $I_L - I_U$-ratios. From that, in connection with the decline of the noise level, a reduction of the detection limit results. The elevated burnup leads for an unlimited test quantity to an additional refinement in identification. (auth)

4227 DETERMINATION OF NITROGEN IN HIGH-TEMPERATURE RESISTANT METAL NITRIDES AND CARBONITRIDES. Rottmann, J.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem.; 247: 208-20(30 Oct 1969). (In German).

The determination of nitrogen content in nitrides and carbonitrides of transition metals is reported. Several methods were compared. The interference of CuO with the reaction mechanism was examined by the Dumas method. By thermodynamic calculations and experimental investigations as well as by x-ray diffraction analysis it was verified that the release of nitrogen is only possible by the use of a CO_2 carrier gas. The modified Dumas method was the most suitable method for a precise and reproducible nitrogen analysis in thermally stable nitrides and carbonitrides. In decomposing nitrides not easily dissolved the Kjeldahl method fails because of the oxidation effect of special solvents. The method of hot extraction with steel, cobalt, and nickel also leads to a decrease in verification. The precipitation of graphite in the melt is clearly responsible for this effect. By means of electron beam microprobe analysis it could be proved that the remaining nitrogen was in the graphite needles, but not as an undecomposed metallic nitride. In general the results of the platin flux method were in good agreement with the results of the methods compared. An analysis without a bath metal was always successful, if the nitride was easy to dissolve, reacted quickly with the carbon of the graphite crucible, and if the melting point of the nitrides or carbides was near working temperature. (auth)

4228 THE SPECTROPHOTOMETRIC DETERMINATION OF THORIUM(IV) WITH 4-(2-THIAZOLYLAZO)-RESORCINOL. Sakai, Takayoshi; Tonosaki, Koichi (Hirosaki Univ., Japan). Bull. Chem. Soc. Jap., 42: 2718-19(Sept. 1969).

Fundamental conditions for the spectrophotometric determination of Th(IV) using 4-(2-Thiazolylazo)resorcinol (TRA) are described. To a sample solution containing up to 95 μg of Th in a 25 ml volumetric flask, 2.5 ml of a $1 \times 10^{-3}\underline{M}$ TAR solution and 15 ml of a 10% wt/vol hexamethylenetetramine buffer solutions with a pH of 7.4 are added; then the solution is diluted to the mark with water. The absorbance of the solution is then measured in a 1 cm cell at 615 mμ, using the reagent blank as a reference. The effects of various ions on the determination at pH 7.4 are given. (P.C.H.)

Radiometric Procedures

Refer also to abstracts 4381 and 4412.

4229 (IEA-170) ROUTINE RADIOMETRIC DETERMINATION OF URANIUM BY GAMMA-RAY SPECTROMETRY. Abrao, Alcidio; Tamura, Harko (Instituto de Energia Atomica, Sao Paulo (Brazil)). Aug 1968. 20p. (CONF-670737-1). Dep. CFSTI (U. S. Sales Only).

From 19th Annual Meeting of Brazilian Society for the Progress of Science, Rio de Janeiro, Brazil.

The routine determination of natural uranium content in uranyl solutions is done by applying gamma spectrometric techniques. The method described is based on the measurement of the ^{235}U photopeak (185-keV); its height is compared with those obtained using standard uranyl solutions. The uranium content of uranyl solutions whose concentrations covered the range from 1 to 500 g/l U were determined. Uranium is determined in aqueous uranyl nitrate and sulfate as well as in organic solutions of tributyl phosphate (TBP)-varsol of various uranyl nitrate concentration. Calibration curves of 1 to 10, 10 to 100, 100 to 300, and 300 to 500 g/l U were constructed. The effect of thorium and its daughters present in aqueous uranyl nitrate and sulfate, for thorium concentration up to 10%, was studied, allowing the conclusion that Th and its daughters do not interfere. The determination of uranium by gamma spectrometry was simplified by using a relatively new uranium, obtained by the chemical treatment of monazite sand, and precipitated as sodium diuranate (SDU) only 10 or less years ago. This raw material has its radiochemical equilibrium affected in such a way that the uranyl solutions prepared by dissolving the SDU contained no radioactive daughters that could interfere with the radiometric determination of uranium. (auth)

4230 (LA-4271) JOINT MEETING 15th ANNUAL BIOASSAY AND ANALYTICAL CHEMISTRY CONFERENCE HELD AT LOS ALAMOS, NEW MEXICO, OCTOBER 9 AND 10, 1969. PROGRAM AND ABSTRACTS. (Los Alamos Scientific Lab., N. Mex.). Oct. 8, 1969. Contract W-7405-eng-36. 51p. (CONF-691015-(Absts.)). Dep. CFSTI.

4231 THE ANALYTICAL METHOD FOR ^{239}Pu BY FISSION TRACKS. Yabuki, Hideo; Shima, Makoto (Inst. of Physical and Chemical Research, Yamato, Japan). Bunseki Kagaku, 18: 1265-7(Oct. 1969). (In Japanese).

The determination of ^{239}Pu by the fission track method, which has been used frequently for the microanalysis on U, was examined. The results are very consistent with expected value from the calculation, and it is revealed that fission track method can be applied conveniently for semiquantitative determination of Pu distribution. (NSA of Japan)

4232 AN ULTRASENSITIVE METHOD FOR THE DETERMINATION OF LOW LEVELS OF RESPIRATORY $^{14}CO_2$ BY LIQUID SCINTILLATION COUNTING. Kearns, Donald S. (Intertech, Inc., North Haven, Conn.). Int. J. Appl. Radiat. Isotop.; 20: 821-4(Dec 1969).

An integrated sample conversion system (Picker Nuclear Benzene Synthesizer), which was originally developed for carbon-14 dating of archeological specimens, was used to convert human respiratory CO_2 into benzene for high efficiency liquid scintillation counting. Results were obtained which indicated that the method was feasible for the determination of ^{14}C activities in the picocurie range (about 2 dpm). The ability to detect such low levels of ^{14}C should appreciably decrease the dosimetry risks involved in the administration of ^{14}C labeled pharmacological agents that might be permanently incorporated into the nucleic acids of human beings. (auth) (UK)

4233 HANDLING LIQUID SCINTILLATION COUNTING DATA WITH SMALL DESK-TOP COMPUTERS. Grower, M. F.; Bransome, E. D. Jr. (Massachusetts Inst. of Tech., Cambridge). Anal. Biochem.; 31: 159-73(1 Oct 1969).

Simple rapid procedures for calculating the absolute radioactivity of samples labeled with one or two isotopes, given the cpm from liquid scintillation counting and an external standard ratio or external count rate, are presented. Data were entered via keyboard into a small off-line laboratory computer, either the Olivetti Programma 101 or the Wang 380 system. Entry was automatic when a Beckman Omega double-tape reader or a Wang tape editor was included in the respective systems. The information for calculating efficiency of counting from an external standard cpm or ratio data was derived from a linear least-square analysis or from a second-order regression analysis carried out with the computers, which were also available for general laboratory computation and statistical analysis. (auth)

4234 A SYSTEM FOR CONVENIENT COMBUSTION PREPARATION OF TRITIATED BIOLOGICAL SAMPLES FOR SCINTILLATION ANALYSIS. Peterson, John I.; Wagner, Frank; Siegel, Sidney; Nixon, Wilbert (National Inst. of Health, Bethesda, Md.). Anal. Biochem.; 31: 189-203(1 Oct 1969).

A combustion system is described, which makes possible the routine preparation of large numbers of biological samples for scintillation counting. The system accepts a variety of sample materials, and a method is provided for evaporating tissue homogenate in gelatin or plastic capsules. An operator drops a capsule in the furnace and collects the combustion products in scintillation solvent, ready for counting, at a rate of 1 sample every 3 min. The system accepts samples of at least 500 mg, limited by solvent capacity for water. A favorable comparison with the oxygen flask method is shown and there is minimum carryover of activity in successive samples. The method has a collection recovery of 96%, is calibrated by internal standards, and shows a coefficient of variation of 2.9%. (auth)

4235 A CARBON DIOXIDE COLLECTION ACCESSORY FOR THE RAPID COMBUSTION APPARATUS FOR PREPARATION OF BIOLOGICAL SAMPLES FOR LIQUID SCINTILLATION ANALYSIS. Peterson, John I. (National Inst. of Health, Bethesda, Md.). Anal. Biochem.; 31: 204-10(1 Oct 1969).

A carbon dioxide collection accessory is described for a previously reported combustion system for preparation of biological samples for liquid scintillation counting. A sample can be burned and collected every 3 min. Sample size is limited by the capacity of the solvent to absorb carbon dioxide without precipitation. The system can be used for collecting water as well as carbon dioxide, for double isotope counting. The method has a collection recovery of 97%, is calibrated by internal standards, and shows a coefficient of variation of 1.1%. (auth)

4236 A SIMPLE AND ULTRASENSITIVE METHOD FOR DETERMINATION OF FREE FATTY ACID BY RADIOCHEMICAL ASSAY. Ho, R. J.; Meng, H. C. (Vanderbilt Univ., Nashville). Anal. Biochem.; 31: 426-36(1 Oct 1969).

A radiochemical assay is described for the quantitative determination of long-chain free fatty acids (FFA) as ^{60}Co-FA complex. The radioactivity of ^{60}Co in Co-FA complex in the upper organic phase is counted. It is sensitive to as low as 0.08 nmole of FFA, and the standard curve is linear up to 200 nmoles. The sensitivity of this method in measuring FFA less than 0.08 or higher than 200 nmoles per assay can be maintained by increasing or decreasing the specific activity of $^{60}Co(NO_3)_2$ used. The accuracy of this method is comparable with other methods. The molar ratio of FFA to Co in Co-FA complex was found to be 2.03 with standard deviation of ±0.16. Therefore, it is a cobaltous salt of fatty acid. This factor of 2 can be used directly for the calculation of the FFA content in the unknown sample. The standard deviation of the mean is approximately 8% of the mean; therefore, it reflects the reliability of this method. (auth)

4237 MEASUREMENT OF ^{32}P FOLLOWING COLORIMETRIC PHOSPHORUS ANALYSIS. Palmer, F. B. St. C. (Dalhousie Univ., Halifax, Nova Scotia). Anal. Biochem.; 31: 493-501(1 Oct 1969).

A procedure for the determination of both ^{32}P and phosphate contents on the same sample is described. Following phosphate estimation by the method of Bartlett, the solution containing the blue reduced phosphomolybdate complex is decolorized at high pH. ^{32}P is measured in this transparent aqueous solution with a liquid scintillation spectrometer, without the addition of scintillators, by utilizing the Cherenkov radiation. (auth)

4238 LIQUID SCINTILLATION COUNTING OF ^{14}C-LABELED HEMIN AND ITS APPLICATION TO THE BIOSYNTHESIS OF HEME IN BONE MARROW. Murty, Hari S.; Nair, Padmanabhan P. (Sinai Hospital of Baltimore, Inc.). Anal. Biochem.; 31: 1-5(1 Oct 1969).

A rapid procedure is described for the liquid scintillation counting of ^{14}C-labeled hemin isolated after incubation of bone marrow with radioactively labeled glycine-2-^{14}C. The method was applied for studies on the biosynthesis of heme in bone marrow of several animal species. (auth)

4239 A RAPID AND SENSITIVE METHOD FOR MEASURING THE BINDING OF RADIOACTIVE LIGANDS TO PROTEINS. Paulus, Henry (Harvard Medical School, Boston). Anal. Biochem.; 32: 91-100(15 Oct 1969).

A new method is described for measuring the binding of radioactive ligands to proteins. The procedure involves the filtering of a solution of the protein and radioactive ligand through a Diaflo ultrafiltration membrane in a specially designed ultrafiltration cell. The membrane, on which the complex of protein and bound ligand is deposited, is then counted in a liquid scintillation spectrometer to yield directly the amounts of ligand bound. The ultrafiltration method of measuring ligand binding is sensitive and rapid. Binding studies can be carried out with microgram quantities of protein and at ligand concentrations exceeding the concentration of protein by several orders of magnitude. With the ultrafiltration cell described, eight samples can be processed simultaneously in less than an hour. (auth)

Activation Procedures

Refer also to abstract 4442.

4240 (IEA-INF-10) NUCLEAR DATA OF SEVERAL RADIOISOTOPES USED IN GAMMA SPECTROSCOPY AND ACTIVATION ANALYSIS. Atalla, Laura T. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Aug 1968. 45p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The report consists chiefly of the following tables: (1) The chemical elements arranged in alphabetic order (by elemental symbol) and corresponding atomic numbers; (2) Radioisotopes produced by the (n,γ) reaction arranged in order of increasing half-life with percent of target isotope, cross sections, x rays in keV, and gamma rays in MeV; (3) Radioisotopes produced by the (n,γ) reaction arranged in order of increasing atomic number with half-life, percent of target isotope, and cross sections; and (4) Radioisotopes produced by the (n,γ) reaction arranged according to the energies of the emitted photons with half-life, percent of target isotope, cross sections, photon energies in MeV, and decay product. (E.J.H.)

4241 DETERMINATION OF EUROPIUM IN MINERALS AND ROCKS BY NEUTRON ACTIVATION AND $\gamma\gamma$-COINCIDENCE SPECTROMETRY. Michelsen, O. B.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Talanta; 16: 1436-9(Oct. 1969).

Neutron activation followed by $\gamma\gamma$-coincidence measurements of 9.3 hr ^{152}Eu is shown to be a convenient method for routine determination of europium in minerals and rocks. In the concentration range 10 to 50 ppM the method is free of interference from other elements, and neutron shielding effects do not interfere seriously in the analysis. The precision of the method is about 5%. (auth) (UK)

4242 MEASUREMENT OF MICRO ELEMENTS IN DENTAL PULP BY ACTIVATION ANALYSIS. Higashi, Tomomitsu; Kawai, Jun-ichi (Kanagawa Dental Coll., Japan). Kokobyogakkai Zasshi, 18: 357-61(July 1969). (In Japanese).

Activation analysis was applied to the measurement of microelements in the dental pulp extracted from diseased teeth of adult men. The elements detected were Na, Cu, Au, As, Fe, Ag, Hg, Sn, and Sb. Irradiation time ranged from 4 to 75 hr depending upon the kind of elements. The amount of As in the dental pulp was also quantitatively determined using arsenous acid deactivating agent. (NSA of Japan)

4243 NONDESTRUCTIVE DETERMINATION OF SODIUM IN SURFACE OXIDE FILM OF SILICON BY NEUTRON ACTIVATION ANALYSIS. Nagashima, Naoyuki; Miyake (Hitachi Ltd., Tokyo). Bunseki Kiki, 7: 31-6(June 1969). (In Japanese).

For the determination of Na in SiO_2 films by measurement of the γ ray of ^{24}Na (2.75 MeV), both samples and standards were irradiated in as nearly the same position in the reactor as possible at a neutron flux of 2.7×10^{12} n/cm² sec for 5 hr. Weighing errors in the standard sample can be neglected in comparison with statistical variation of counting. The detection limit was 0.5 to 1 × 10^{-9} g, and the relative accuracy of the measurement was ±50 to 80%. Since the 1.26-MeV γ ray of the Si, which is produced simultaneously, interferes with the 1.37-MeV γ ray of ^{24}Na it could not be used for the determination. The content of Na in the base material was about the same order as the detection limits and could be removed by an HF treatment. The Na contamination was best removed from the Si wafers before oxidation to the SiO_2. (NSA of Japan)

4244 MULTIPARAMETER COINCIDENCE SPECTROMETRY APPLIED TO THE NON-DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF METEORITES. Morgan, J. W.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Anal. Lett.; 2: 537-45(Oct 1969).

A nondestructive method for the neutron activation analysis of chondritic meteorites by multiparameter coincidence spectrometry is described. Results for sodium, cobalt, nickel, and iridium are presented, and agree with single coincidence spectrometry measurements. Scandium photopeaks are prominent in the multiparameter spectrum and this element could also be determined. The advantages of multiparameter spectrometry over single coincidence counting are outlined. (auth)

4245 DETERMINATION OF SILICON IN INTACT STEEL SAMPLES WITH A LOW OUTPUT NEUTRON GENERATOR. Pierce, T. B.; Haines, K. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst; 94: 886-7(Oct 1969).

A low output sealed-tube neutron generator was used to determine the silicon content of steels by neutron activation analysis. Counting and flux monitoring were carried out with simple equipment. (auth) (UK)

4246 IRON WIRE CONTAINING MANGANESE AS FLUX MONITORS IN ACTIVATION ANALYSIS USING SHORT-LIVED RADIO NUCLIDES. Das, Sankar M. (Bhabha Atomic Research Centre, Trombay, India); Il, Kim Won; Chul, L. Int. J. Appl. Radiat. Isotop.; 20: 746-7(Oct 1969).

The use of commercial iron wires as flux monitors for activation analysis was studied in the Seoul TRIGA Mark II Reactor. The ^{56}Mn activity produced in wire samples was measured and the samples were found to contain about 0.4% of Mn. Variations in samples from one wire did not exceed 2% of the Mn content. Yields from fast neutron reactions were not sufficient to cause any serious disturbance. A monitoring element used in a dilute alloy has the advantage that the amount of material used can be large enough to be weighted with an ordinary balance, and the activity produced sufficiently low to be measured close to an ordinary NaI crystal. (UK)

4247 ESTIMATION OF GAMMA-RAY DOSE FROM NEUTRON-INDUCED RADIOACTIVITY IN HIROSHIMA AND NAGASAKI. Hashizume, Tadashi; Maruyama, Takashi; Kumamoto, Yoshikazu; Kato, Yoshio; Kawamura, Shoichi (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 17: 761-71(Dec 1969).

The gamma-ray dose from the radioactivity induced in soil and building materials by neutrons was estimated on the basis of the experimental data. The chemical compositions of soil and building materials collected from Hiroshima and Nagasaki were determined by an activation analysis. It was found that ^{24}Na and ^{56}Mn contributed mainly to the gamma-ray dose from the radioactivity induced in soil. The dose received by a person who entered the hypocenter area in Hiroshima one day after the bombing and remained there for 8 hr would have been 3 rads. The doses at distances of 500 m and 1000 m from the hypocenter in Hiroshima were 18% and 0.07% respectively, of that at the hypocenter. The accumulated gamma-ray dose from immediately after the explosion of the A-bombs to infinity was about 80 rads at the hypocenter in Hiroshima, and about 30 rads in Nagasaki. (auth) (UK)

4248 DETERMINATION OF MICROCOMPONENTS IN POLYETHYLENE AND TEFLON BY THE METHOD OF RADIOACTIVATION ANALYSIS. Draskovic, R. J.; Kukoc, A.; Draskovic, R. S. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Isotopenpraxis; 5: 256-8(Jul 1969).

Microcomponents in polyethylene of Yugoslav production and teflon of Swiss production were determined by the method of radioactivation analysis. The microcomponents Cu, Mn, and Na were determined from the characteristic photopeak energies of 0.511-MeV (^{64}Cu), 0.850-MeV (^{56}Mn), and 1.368- and 2.770-MeV (^{24}Na) and the corresponding half-lives of these radioisotopes. The concentrations of these microcomponents were determined by the comparison method. (auth)

4249 PROCESS TO MANUFACTURE DOSE STANDARDS OF OXYGEN FOR ACTIVATION WITH NEUTRONS OF 14 MeV. Perdijon, J. (CEN, Grenoble, France). Nucl. Instrum. Methods; 75: 331-2(1969). (In French).

After recalling the general conditions to make standards for neutron activation analysis, a process to manufacture homogeneous oxygen standards by mixing stearic acid with paraffin wax in a polyethylene vial is proposed. (auth)

4250 DETERMINATION OF TIN IN GEOLOGICAL MATERIAL BY NEUTRON-ACTIVATION ANALYSIS. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Analyst; 94: 976-8(Nov 1969).

A neutron-activation method for the determination of tin in geological material, based on tin-113 (half-life 112 days), is described. Tin is radiochemically separated from the irradiated samples after alkaline fusion by a method consisting of two sulphide precipitations with an intermediate extraction of tin from 5 M ammonium thiocyanate with diethyl ether. The sensitivity of the method at a neutron flux of 10^{12} neutrons cm^{-2} s^{-1} is about 0.2 μg of tin, if irradiation is applied for 14 days. (auth) (UK)

4251 DETERMINATION OF LUTETIUM, YTTERBIUM, AND TERBIUM IN ROCKS BY NEUTRON ACTIVATION AND MIXED SOLVENT ANION-EXCHANGE CHROMATOGRAPHY. Brunfelt, A. O. (Univ. of Oslo); Steinnes, E. Analyst; 94: 979-84(Nov 1969).

Lutetium, ytterbium, and terbium were determined in some standard rocks from U. S. Geological Survey of neutron-activation analysis. A chromatographic procedure involving anion exchange in a mixed solvent system was developed to obtain selective separation of the required radioisotopes from other activities induced during the irradiation. Lutetium and ytterbium are eluted in the same fraction, while terbium is obtained in a separate fraction. Chemical yield determination is performed by re-activation. The precision of the method was about ±5 to 15% for the samples analyzed. (auth) (UK)

4252 A METHOD FOR THE SEPARATION OF THE ^{15}O ISOTOPE DURING THE RADIOACTIVATION DETERMINATION OF OXYGEN IN PURE MATERIALS. Vasserman, A. M.; Chapyzhnikov, B. A.; Kunin, L. L.; Yakovlev, Yu. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 24: 1710-13(Nov 1969). (In Russian).

A method previously developed for the impulse heating of samples in graphite capsules in an inert gas medium was used for the rapid separation of the ^{15}O short-lived isotope during the radioactivation determination of oxygen by the photonuclear reaction $^{16}O(\gamma,n)^{15}O$. A setup was tested including a reaction chamber for the extraction of $C^{15}O$, an oven with copper oxide for the oxidation of $C^{15}O$, and a catcher with KOH powder for absorption of radioactive carbon dioxide; the catcher is placed between two scintillation crystals. It was found experimentally that the process of the radiochemical separation of ^{15}O including the etching of the surface of the irradiated sample takes not more than 1.5 to 2 min. It was calculated that on the irradiation of the analyzed materials on the microtron with the energy of speeded electrons of 27 MeV and the mean current to the target of 10 μA the sensitivity of oxygen determination in 1 g samples is 10^{-5}%. (auth)

4253 ACTIVATION ANALYSIS OF RESORBED ELEMENTS BY ENRICHED STABLE ISOTOPES. Ritzl, F.; Kasperek, K. (Kernforschungsanlage, Juelich, Ger.). Elektromedizin; 12: 236-9(Nov 1967). (In German).

Activation analysis in determining resorbed elements by means of enriched stable isotopes is reported. While a radiation exposure of the examinee must be taken into account when using radioisotopes, the method described does not involve any radiation exposure and the accuracy of the analysis remains unchanged. Therefore this method can be applied to all groups of persons. (auth)

4254 USE OF SHORT-LIVED RADIOISOTOPES IN THE DETERMINATION OF TRACE ELEMENTS IN HIGH-PURITY METALS BY NEUTRON ACTIVATION. Deschamps, N.; Fedoroff, M. (CECM, Vitry-sur-Seine, France). Z. Anal. Chem.; 247: 221-4(30 Oct 1969). (In French).

A complete study of high-purity metals must include the determination of some elements giving only short-lived radioisotopes by the (n,γ) reaction. In the case of elements giving also long-lived radioisotopes, the use of a short-lived isotope may be advantageous in two cases: possibility of a rapid nondestructive analysis or better sensitivity. The determination of aluminum in iron, zirconium, and molybdenum and of cobalt in iron and nickel is described in detail. When necessary rapid chemical separations were developed. The determinations permit the purification of the metals studied to be followed. (auth)

4255 USE OF A Ge(Li) DETECTOR IN RADIOCHEMICAL ANALYSIS. I. ACTIVATION ANALYSIS OF PPM AMOUNTS OF

TELLURIUM IN SELENIUM. Neeb, K. H.; Franke, R.; Neidl, H. (Siemens AG., Erlangen, Ger.). Z. Anal. Chem.; 247: 225-8 (30 Oct 1969). (In German).

The very high energy resolution of Ge(Li) detectors in γ spectrometry enables chemical separation processes to be shortened quite considerably in many cases of radiochemical analysis. At photo peak efficiencies between 3% (at 0.1 MeV) and 0.1% (at 1 MeV) this detector is especially suitable for measuring activities in the order of 1 to 100 nCi. For the determination of small amounts of tellurium in selenium by means of neutron activation analysis and measurement of ^{131}I, a quick single-step separation suffices if a Ge(Li) detector is used. Between 5 and 100 ppM of tellurium can be thus determined with a relative standard deviation of 5 to 10% in small samples of selenium weighing between 5 and 20 mg. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 4249, 4331, 4347–4349, 4733, 4739, 4763, and 4842.

4256 (BNL–13651) VAPORIZATION OF FISSION PRODUCTS FROM IRRADIATED URANIUM. II. SOME OBSERVATIONS ON THE CHEMICAL BEHAVIOR OF FISSION PRODUCTS IODINE AND CESIUM. Castleman, A. W. Jr.; Tang, I. N. (Brookhaven National Lab., Upton, N. Y.). May 1969. 24p. Dep. CFSTI.

The results of an experimental investigation of the chemical nature of fission products iodine and cesium vaporized from irradiated uranium specimens into helium and air are reported. The thermochromatographic technique was employed in the study. It was observed that iodine released from uranium heated to 1250°C in helium was not in chemical combination with either cesium or any other fission product, but rather was vaporized as a uranium-iodine compound. Partial dissociation of this compound into atomic iodine occurred when the uranium was heated to temperatures above 1900°C. In an oxidizing atmosphere, only elemental iodine was vaporized. (auth)

4257 (CEA-Bib–174) NEPTUNIUM HEXAFLUORIDE. Matcheret, Georges; Bourgeois, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1969. 19p. (In French). Dep. CFSTI (U. S. Sales Only).

This compound is generally prepared by the reaction of either a lower fluoride or an oxide of neptunium with fluorine or a halogen fluoride. The molecule has a regular octahedral structure; the neptunium atom is located in the center of an octahedron, the apexes of which are occupied by fluorine atoms. When cold, it appears as an orange crystallized solid. It melts around 54.4°C and boils around 55.2°C under air pressure. Very sensitive to hydrolysis, it is easily reduced by photodecomposition, by bromine, and also after reaction with some metallic fluorides (sodium fluoride, magnesium fluoride). (auth)

4258 (CU–755-6, Sect.3)) A STUDY OF SOME FACTORS AFFECTING THE RATE OF ^{15}N EXCHANGE BETWEEN NITRIC OXIDE AND NITRIC ACID IN AN EXCHANGE COLUMN. Garbazevich, Jaime (Columbia Univ., New York. Dept. of Chemistry). 133p.

Studies were made on the kinetics and mechanism of the exchange of ^{15}N between NO and HNO_3 from the effects of temperature, acidity, and added salts, such as $NaHSO_4$, $HClO_4$, Na_2SO_4, $NaNO_3$, $NaClO_4$, and H_2SO_4. In order to obtain a measure of the exchange rate from the overall separations S at the steady state, it was necessary to evaluate the effective single stage enrichment factors α for each solution. Three different methods were used to evaluate the effective separation factors designated as α_{exp}, $\alpha_{p,t}$, and $\alpha_{p,e}$. α_{exp} was a direct experimental measurement of the ^{15}N to ^{14}N atom fraction ratio in the liquid divided by the same ratio in the gas phase. $\alpha_{p,t}$ was obtained from the gas–liquid composition and the theoretical values of the partition function ratios for the species involved in each exchange reaction. For this study $\alpha_{p,e}$, which is a combination of theoretical and experimental values for the individual exchange, reactions were considered more reliable. Calculated parameters for the preparation of high concentrations of ^{15}N showed that 6$\underline{M}$ HNO_3 + 2$\underline{M}$ H_2SO_4 was was a significant improvement over 6$\underline{M}$ HNO_3 and equal to 10$\underline{M}$ HNO_3 with respect to equilibrium time. However, the length and volume of column was more favorable for 10$\underline{M}$ HNO_3. (P.C.H.)

4259 (CU–755-6, Sect.7-B) TESTS OF AN APPARATUS FOR RELATIVE PLATE EFFICIENCIES FOR DEUTERIUM EXCHANGE BETWEEN METHYLACETYLENE AND WATER. Todosow, Michael (Columbia Univ., New York. Dept. of Chemistry). 6p.

The operation of an apparatus similar to that used for measuring plate efficiencies was tested for use in the evaluation of the effectiveness of various catalysts in deuterium exchange between methylacetylene and water. Preliminary tests were made on NaOH-catalyzed exchange of deuterium between methyl acetylene and water. For a contact time of about 1 sec the equilibration was about 43% complete for a 2$\underline{M}$ NaOH and about 36% for 0.5$\underline{M}$ NaOH. The differences were greater at contact times of about 2 sec. The principal advantage of the method used is that it can be used with slight modifications for comparisons of heterogeneous catalysts. Data are tabulated. (P.C.H.)

4260 (CU–755-6, Sect.7-C) HOLD-UP OF AMINES ON PACKING MATERIALS FOR EXCHANGE COLUMNS. Zia, Franklin C. (Columbia Univ., New York. Dept. of Chemistry). 7p.

Studies were made on the hold-up of triethylamine (TEA) and various solutions of di-n-butylamine (DNBA) in triethylamine on stainless steel helices (Helipak 3031) in order to evaluate some systems involving isotope exchange. The results on hold-up per cubic centimeter of packing vs flow rate showed that doubling the flow rate increased the hold-up by only about 20%. Data are tabulated for the hold-up of methanol, triethylamine, and solutions of DNBA in TEA. (P.C.H.)

4261 (ORNL–TM–2715) THE ROLE OF CARBON IN REACTIONS IN THE U–C–O–N SYSTEM. Lindemer, T. B.; Leitnaker, J. M.; Spear, K. E. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 25p. (CONF-690927–1). Dep. CFSTI.

From International Conference on Heterogeneous Kinetics at Elevated Temperatures, Philadelphia, Pa.

Carbon plays a vital role in reactions in the U-C-O-N system. This was demonstrated by extensive studies of the kinetics and thermodynamics of reactions in the system from 1400 to 2000°C, including those of UO_2 with carbon, UC with nitrogen, and UC_2 with nitrogen. Carbon can either act as a reductant or can control the reaction rate. It can control the rate of reactions either by diffusion processes, by the distribution of free carbon within the solid reactants, by the formation of compounds more rich in carbon, or by the formation of a nonequilibrium type of free carbon. In all cases, the role of carbon is dominant. (auth)

4262 (RFP-Trans–61) PROTON RESONANCE STUDIES IN PARAMAGNETIC ORGANOMETALLIC URANIUM(IV)–ALKOXY-COMPLEXES. Ammon, R. v.; Kanellakopulos, B.; Fischer, R. D. Translated for Dow Chemical Co., Golden, Colo., from Radiochim. Acta, 11: 162-8(1969). 19p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 40649.

4263 (UCRL-Trans–10394) ABSORPTION SPECTRA OF URANYL NITRATE CRYSTALS. Komyak, A. I.; Shevchenko, A. N.; Ditsh, E. V. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk BSSR; 12: 9(1968). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 9373.

4264 REACTIONS OF LIQUID SODIUM WITH TRANSITION-METAL OXIDES. PART III. THE OXIDES UO_3 AND U_3O_8. Addison, C. C.; Barker, M. G.; Lintonbon, R. M.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., A; No. 16, 2457-9 (1969).

At 400°C liquid sodium reduces uranium trioxide to the dioxide, no double oxide being present in the product. At 600°C, the product contains sodium uranate(V), Na_3UO_4. Thermal analysis indicates that at 540°C sodium oxide and uranium dioxide react to form sodium uranate(V), for which an x-ray powder diffraction pattern is reported, and the reactions in liquid sodium are interpreted on this basis. The oxide U_3O_8 behaves as a mixture of UO_3 and UO_2. (auth) (UK)

4265 ULTRAVIOLET-ACTIVATED SYNTHESIS OF PLUTONIUM HEXAFLUORIDE AT ROOM TEMPERATURE. Trevorrow, L. E.; Gerding, T. J.; Steindler, M. J. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett.; 5: 837-9(Oct 1969).

Literature reports indicate that pure PuF_6 is decomposed by light. It has also been observed that the irradiation of pure, gaseous PuF_6 by ultraviolet light at room temperature results in the production of a solid, suggesting the decomposition of PuF_6. Studies are described in which it was observed that the ultraviolet irradiation of mixtures of solid PuF_4 and gaseous fluorine at room temperature resulted in the production of PuF_6. (auth) (UK)

4266 H–D ISOTOPE EFFECT IN THE REACTION OF HYDROGEN RADICALS WITH ISOPROPYL ALCOHOL IN 6M–

H_2SO_4 IN THE LIQUID AND IN THE GLASSY STATE. **Vacek, K.; von Sonntag, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Chem. Soc., D; No. 21, 1256-7(1969).**

The kinetic isotope effect (k_H/k_D) for hydrogen abstraction from $(CH_3)_2CHOH$ and $(CD_3)_2CDOH$ by hydrogen atoms in 6M H_2SO_4 was found to be 10.1 at 299°K, 18.1 at 253°K, and only 2.2 at 90°K, indicating that at 90°K the reaction is mainly diffusion controlled. (auth) (UK)

4267 THE NONIDEALITY OF LIQUID AND SOLID ORTHO-PARA DEUTERIUM SOLUTIONS FROM VAPOR PRESSURE MEASUREMENTS. **Meckstroth, Wilma Koenig. Columbus, Ohio, Ohio State Univ., 1968. 137p.**

Thesis.

The difference in vapor pressures between equilibrium deuterium (2.15% para) and solutions of higher para composition was measured as a function of temperature for both the liquid and solid state. The temperature and ortho-para composition range of the measurements were for the liquid solutions 18.7 to 22.5°K and 14.2% para to 80.0% para, respectively, and for the solid solutions 14.0 to 18.6°K and 14.2% para to 80.0% para, respectively. The statistical mechanical treatment proposed by Babloyantz and Bellemans was used to determine the origin of the nonidealities in liquid and solid solutions of ortho-para deuterium. The model employed in the treatment is one that assumes a rigid lattice and both isotropic and anisotropic pair interactions. It is shown that the experimental data can be accounted for when the anisotropic part of the pair interactions is principally due to the molecular quadrupole moment and the isotropic part, the usual Lennard-Jones interaction that is averaged over all molecular orientations. The magnitude of the molecular quadrupole moment, Q, and the depth of the potential well, ϵ_{00}/k, characterizing the isotropic interactions needed to account for the experimental data are, however, somewhat different from those corresponding to the gas, $Q = 0.136 Å^2$, $\epsilon_{00}/k = 37.00$ degrees. From the present results $Q = 0.130 Å^2$, $\epsilon_{00}/k = 55.0$ degrees. A summary of the thermodynamic properties of the liquid and solid solutions as a function of ortho-para composition at the average temperature of the experiments together with the results calculated from a theoretical model is presented. (Disser. Abstr.)

4268 PREPARATION AND CRYSTAL CHEMISTRY OF SOME REFRACTORY BORIDES AND PHOSPHIDES. **Lundstroem, Torsten (Uppsala Univ.). Ark. Kem.; 31: 227-66 (1969).**

The methods for preparation of borides and phosphides are reviewed. In particular, the direct synthesis from the elements is discussed. A critical survey of the binary transition metal–boron systems and the fourth to sixth group transition metal–phosphorus systems is given. The structures belonging to the AlB_2 structure family are described. The following structure types are members of this family: AlB_2, ReB_2, Mo_2B_5, W_2B_5, $Mo_{1-x}B_3$, RuB_2, and $IrB_{1.35}$. A characteristic feature of these structures is that they contain planar or puckered nets of B atoms. The structure of CrB_4 was compared with that of ThB_4. Both structures contain three-dimensional boron networks. It is pointed out that there is experimental evidence for the occurrence of holes in the structures of Ru_2B_3, WB_2, $Mo_{1-x}B_3$, and CrB_4. These holes are of convenient size for boron atoms but do not accommodate any such atoms. The importance of Me–B interactions in phases of the ReB_2 type is stressed. The coordination numbers of the atoms in the metal-rich phosphides of the fourth to sixth group transition metals are very high which results in good space filling. The phosphorus atoms do not form short P–P contacts. The metal atoms in the diphosphides have a trigonal prismatic environment of phosphorus atoms but there are no P–P contacts between the phosphorus atoms within the prism. Phosphorus pairs or chains occur between the prisms. General structural principles, physical properties, and chemical bonding in borides and phosphides are discussed. (auth) (Sweden)

4269 ISOTOPE EFFECTS IN THE REACTION OF α-HYDROXY-ALKYL RADICALS WITH t-BUTYL PEROXIDE. Huyser, Earl S.; Kahl, Allan A. (Univ. of Kansas, Lawrence). J. Chem. Soc., D; No. 21, 1238-9(1969).

A primary isotope effect observed in the decomposition rate of t-butyl peroxide in [O-$^2H_1$]butan-2-ol indicates that transfer of the oxygen-bonded hydrogen occurs in the induced decomposition of the peroxide by the alcohol-derived α-hydroxy-alkyl radical. (auth) (UK)

4270 METAL POWDER CONTAINING TRITIUM. **(to Philips Electronic and Associated Industries Ltd.). British Patent 1,164,398. Sept. 17, 1969. Priority date July 23, 1966, Netherlands.**

A metal powder containing T was produced by bringing finely divided metal powder into contact with T without heating, then heating the powder obtained to 500°C, cooling the powder, and bringing the powder into contact with the ambient atmosphere. Substantially no T was released on heating the powder obtained to 490°C. If the powdered metal is Ti, a powder of approximate composition $TiT_{0.01}$ is obtained. (B.L.M.)

4271 RELATIONSHIP BETWEEN KINETIC HYDROGEN ISOTOPE EFFECTS AND TRANSITION STATE SYMMETRY IN ELECTROPHILIC AROMATIC SUBSTITUTION. **Hanna, S. B.; Fermini, C.; Zollinger, H. (Technische Hochschule, Zurich). Tetrahedron Lett.; No. 51, 4415-6(Nov 1969).**

In an attempt to study the relationship between k_H/k_D and the Bronsted catalysis law parameter β, the diazo coupling of 2-aminophenol-4-sulphonic acid with 1-naphthol-2-sulphonic acid in aqueous buffer solutions was examined. This reaction proceeds with the formation of a ketone-like σ complex from which the proton transfer is rate limiting, and is subject to general base catalysis; a Bronsted plot covering a range of 10′′ in basicity constants gave $\beta = 0.37$. If this value is taken as a measure of the degree of proton transfer it would be expected that k_H/k_D would be about the same for the variety of bases used in the study. When measured k_H/k_D values at 0°C were plotted against the pK_a values of the bases a maximum was seen at $pK_a \approx 1$. It is believed that this is the first such reported behavior for an electrophilic substitution proper. The behavior is predicted from isotope effect theory. It is considered that the difference in basicity between the proton donor and proton acceptor (ΔpK_a) may be a far better measure than β of transition state symmetry. (UK)

4272 ESTIMATION OF THE SIZE DISTRIBUTION OF URANIUM OXIDE PARTICLES BY ALPHA-RAY SPECTROMETRY. **Fujita, Akira; Matunami, Tadao (Osaka Prefectural Radiation Center). Hoken Butsuri, 4: 550-5(Sept. 1969). (In Japanese).**

The possibility of estimating the size distribution of uranium oxide particles by α spectrometry was investigated. Alpha spectrometric measurements were made of several samples of uranium oxide particles of different sizes, which were prepared by the sedimentation method. A rough estimation of the size distribution of uranium oxide particles is possible for the particles in a size range of 0.5 to 10μ in diameter by measuring the shift of the peak position and the broadening of the peak width. (NSA of Japan)

4273 APPLICATION OF VAPOR PRESSURE OSMOMETRY TO THE STUDY OF URANYL NITRATE AND THORIUM NITRATE COMPLEXES WITH TRIBUTYL PHOSPHATE. **Apelblat, A.; Hornik, A. (Israel Atomic Energy Commission, Negev). Israel J. Chem., 7: 45-8(Jan.-Feb. 1969).**

Molecular weights of $UO_2(NO_3)_2$ and $Th(NO_3)_4$ dissolved in tributyl phosphate (TBP) were determined using vapor pressure osmometry. Measurements of the $UO_2(NO_3)_2$–TBP system were made in a CCl_4 medium. The formation of an AB_2 type complex only, $UO_2(NO_3)_2 \cdot 2TBP$, is suggested by the dependence of $\overline{M}$, the average molecular wt, on X_B°, the initial mole fraction of TBP. For the complex itself $\overline{M}$ was also measured in acetone also; the value found was 611, as compared with 926 in CCl_4. This lowering can be explained by assuming dissociation of the complex, or substitution of TBP as a ligand by acetone. The following model for Th studies was examined: $Th(NO_3)_4 \cdot 2TBP = Th(NO_3)_4 \cdot 3TBP$. The average equilibrium constant for this reaction at 25° is 30 and at 37°, 16. For $Th(NO_3)_4$–TBP in chloroform solutions, values of $\overline{M}$ deviate less than in CCl_4 solutions from linear correlation, calculated for AB_2 type complex only. The experimental curves of $\overline{M}$ dependence on X_B° can serve as calibration curves for analytical uses. (BBB)

4274 DENSITIES AND EQUIVALENT CONDUCTIVITIES OF FUSED UCl_3 AND UCl_3–KCl SYSTEMS. **Mochinaga, Junichi; Cho, Kangjo (Tokyo Inst. of Tech.). Denki Kagaku, 37: 654-8 (Sept. 1969). (In Japanese).**

Densities and equivalent conductivities were determined as a function of temperature for fused UCl_3 and UCl_3–KCl systems. Expansivity and molar expansibility of fused UCl_3 were calculated from density data, giving a molar volume change of 14.9% of UCl_3 on melting. Activation energy of UCl_3 for conduction changed from 156 to 9 kcal equiv^{-1} over a 30°C temperature range. This indicated that liquid UCl_3 probably has a large polymerized lattice in equilibrium with ionic entities immediately above the melting point. Molar volume isotherms of the UCl_3–KCl system showed quite marked positive deviations from additivity at low temperature, but the deviations decreased with increases in temperature. Equivalent conductivities of the fused UCl_3–KCl system were in good agreement with the values calculated by modified Markov's equation, where the equivalent fractions were used instead of mole fractions in the fused salt mixture. (NSA of Japan)

4275 DENSITIES AND EQUIVALENT CONDUCTIVITIES OF FUSED UCl_3–NaCl AND UCl_3–KCl.NaCl (e.m.) SYSTEMS.

Mochinaga, Junichi; Cho, Kangjo (Tokyo Inst. of Tech.). Denki Kagaku, 37: 658-61(Sept. 1969). (In Japanese).

Densities of fused UCl_3-NaCl and $UCl_3-KCl-NaCl$ (e.m.) systems were measured and empirical equations for these systems were determined as a function of temperature. Molar volumes of these systems were calculated from density data, and compared with the additivities. Molar volume isotherms of the both systems show the positive deviations from additivities at 700°C, but the deviations decreased with increase in temperature. In the case of $UCl_3-KCl-NaCl$(e.m.) system, the negative deviations were observed at 1000°C in the range of more than 15 mol % of UCl_3. From the specific conductivities and densities, the equivalent conductivities were obtained for these systems, and compared with the values calculated by modified Markov's equation. (NSA of Japan)

4276 SURFACE IONIZATION AND THERMOELECTRONIC PROPERTY OF URANIUM DIOXIDE. Sasaki, Noriaki; Kubo, Kenji (Kyoto Univ.). Shitsuryo Bunseki, 17: 745-53(Sept. 1969).

The ionic species emitted from UO_2 on W and Re filaments by surface ionization were identified as UO_2^+, UO^+, and U^+. The UO_3^+ ion could not be observed under any conditions. By measuring ionic currents of $^{238}U^{16}O_2^+$ and $^{238}U^{16}O^+$ the values of the heats of vaporization of UO_2^+ and UO^+ were estimated. The value of UO_2^+ changes at about 2230°K for the W filament and 2080°K for the Re, respectively, and the values for the higher temperature range are larger than those for the lower range, irrespective of the filament materials. The thermoelectronic properties of UO_2 were studied. The work function of the filament covered with the UO_2 changes at the specific temperature similarly to the ionic emission of UO_2^+. From the experimental data of the ionic emissions of UO_2^+ and UO^+, and those of the thermoelectronic emissions, the heats of vaporization of UO_2 and monoxide molecules from UO_2 oxide on the W and Re filaments were also calculated. (NSA of Japan)

4277 THE VAPORIZED AMOUNTS, VAPORIZATION BEHAVIOR, AND SPECTRAL LINE INTENSITY OF EUROPIUM IN GRAPHITE POWDER BY ARC DISCHARGE. Osawa, Hisao (Fuji Electric Co., Yokosuka, Japan). Bunseki Kiki, 7: 690-6 (Oct. 1969). (In Japanese).

The relations between vaporized amounts, vaporization behavior, and spectral line intensity of Eu in graphite powder were examined with graphite electrodes under varying arc discharge conditions and and buffer concentrations. Standard samples were prepared with highly purified graphite powder containing 216 ppM of Eu as Eu_2O_3 and various concentrations of NaF as a spectrographic buffer. The element was excited by dc arc discharge, and the concentration of Eu remaining in graphite powder after the discharge was measured by the neutron activation analysis. The vaporized amounts increased and the temperature of the anode was raised with an increase of the arc current. The spectral line intensity of Eu 2813.9 Å depended on vaporized amounts in the Ar atmosphere. Under the conditions involving arc current 4.9 to 5.0 A, electrode gap 3 mm, discharge time 60 sec, and NaF concentration 1.0 to 2.0%, the vaporized amounts were $7.7_8 \times 10^{-6}$g/mg sample at the anode crater in the air and $3.8_9 \times 10^{-6}$ g/mg sample in Ar atmosphere. At the same anode temperature, the amount of Eu vaporized in air or Au was about the same, but the line intensity of Eu 2813.9 Å was higher in the latter. In spite of the difference in boiling point of Eu and Na, the vaporization behaviors of the two elements in a spectrographic buffer of NaF were closely related. The vaporized amounts of Eu in the sample without NaF was independent of the discharge time, both in the air and in Ar atmosphere. (NSA of Japan)

4278 THE DECOMPOSITION PRODUCTS OF SOLUTIONS OF EUROPIUM AND YTTERBIUM METALS IN LIQUID AMMONIA. Howell, K.; Pytlewski, L. L. (Drexel Inst. of Tech., Philadelphia). J. Less-Common Metals, 19: 399-404(Dec. 1969).

At −50°C, the diamide, $Yb(NH_2)_2$, is the predominant decomposition product of liquid ammonia solutions of ytterbium metal. Europium metal solutions decompose to form the diamide exclusively at −50°C. Thermal decomposition leads to the imide, EuNH, for europium, and the nitride, YbN, for ytterbium. The heats of solution of europium and ytterbium in liquid ammonia were calculated to be −20.9 and −19.4 kcal/g-at., respectively. The processes leading to formation of the diamide and triamide were examined, and it is shown why the differences in both the decomposition of the metal solutions and the thermal decomposition products occur. (auth)

4279 STUDIES OF THE DOUBLE LAYER AT OXIDE-SOLUTION INTERFACE. Ahmed, Syed M. (Dept. Energy, Mines, and Resources, Ottawa). J. Phys. Chem.; 73: 3546-55(Nov. 1969).

Data were obtained on the following double-layer characteristics of Al_2O_3, ZrO_2, and ThO_2 by measuring the equilibrium distribution of the potential-determining ions (H^+, OH^-) at the oxide-solution interface as a function of pH_s and of the ionic strength of the solution: (a) the zero point of charge, (b) the surface-charge densities, $q^{\pm}$, of Al_2O_3 in KNO_3, KCl, and $NaClO_4$ solutions and q^+ of ZrO_2 and ThO_2 in KCl and $NaClO_4$ solutions, (c) the differential capacity of the double layer on Al_2O_3, and (d) the change in the interfacial energy resulting from ionic adsorption. Results and previous work on other oxides (SiO_2, ZrO_2, ThO_2, Fe_2O_3, Fe_3O_4, SnO_2, and TiO_2) were correlated to elucidate the general mechanisms of surface-charge formation and of ionic adsorption on oxides. The anions or cations may be specifically adsorbed on oxides through a basic or an acidic dissociation of the surface hydroxyl groups, respectively. An isotherm was derived for the specific adsorption of K^+ on the cathodic surfaces of oxides and the $\Delta G^0_{K^+}$ was calculated from this isotherm for different oxides. The variation of $\Delta G^0_{K^+}$ with pH, with a_{KNO_3}, and with surface coverage and also the relationship of $\Delta G^0_{K^+}$ with the ζ potentials of oxides was discussed. (auth)

4280 PROTON SPIN RELAXATION AND EXCHANGE PROPERTIES OF HYDRATED CHROMIC IONS IN H_2O AND H_2O–D_2O MIXTURES. Melton, B. F. (Oklahoma State Univ., Stillwater); Pollak, V. L. J. Phys. Chem.; 73: 3669-79(Nov 1969).

Experimental results are presented on proton spin relaxation in Cr(III) solutions of H_2O and mixtures of H_2O and D_2O, in fields from 1.1 G to 14 kG, and at temperatures from 0 to 99°C. Water solutions containing 0.10 M $HClO_4$ give results which reflect the relaxation and exchange properties of $Cr(H_2O)_6^{3+}$ alone, uncomplicated by the effects of hydrolysis products or polymers which cause thermal hysteresis or by acid-catalyzed proton exchange, which is present in solutions of high acidity. Measurements on weakly acidified solutions confirm that $Cr(H_2O)_6^{3+}$ is a more strongly relaxing species than $Cr(H_2O)_5OH^{2+}$, but the latter undergoes more rapid proton exchange with the solvent water. A homogeneous (local) proton exchange mechanism involving the coordinated OH^- ion is proposed to account for this result. Measurements on 0.10 M $HClO_4$ solutions containing varying mole fractions of H_2O and D_2O indicate that the principal effect of deuteration at low temperatures is an increase in the lifetime of protons in the primary hydration sphere of Cr^{3+}, resulting from the greater basicity of H_2O as compared to D_2O. At high temperatures T_2 remains constant, whereas T_1 decreases with deuteration due to slower rotational motion of the hydrated complex. The latter is correlated with the marked increase in viscosity which occurs in going from H_2O to D_2O. (auth)

4281 THREE-ELEMENT REACTION COORDINATES AND INTRAMOLECULAR KINETIC ISOTOPE EFFECTS. Kass, William J.; Yankwich, Peter E. (Univ. of Illinois, Urbana). J. Phys. Chem.; 73: 3722-35(Nov 1969).

A convenient form is developed for expressing the limitations upon the relative contributions to a reaction coordinate of three internal coordinate displacements imposed by the condition that there be a single zero (and no negative) vibrational eigenvalue at the transition state. The method is applied to exploration of the consequences of reaction coordinate "composition" variations for values of the temperature-dependent (TDF) and temperature-independent (TIF) factors in an intramolecular kinetic isotope effect. The related influences of changes in temperature, shifts in force constant values, etc., are studied also. For most reaction coordinates (but for none at high temperature), the contributions of TIF to the isotope effect are small in comparison with those of TDF. For both TIF and TDF, changes in the relative signs of given component displacements in the reaction coordinate yield effects which can be large compared with those arising in (a) displacement relative magnitude shifts of 10 to 30%; (b) temperature changes of several hundred degrees; or (c) alterations of 25 to 100% in values of diagonal force constants of "isotopic" internal coordinates. Some problems associated with the occurrence of multiple nonpositive eigenvalues are examined briefly. (auth)

4282 KINETIC ISOTOPE EFFECTS. PART 6. IONIZATION OF 2-CARBETHOXYCYCLOPENTANONE. Jones, J. R. (Univ. of Surrey, London). Trans. Faraday Soc.; 65: 2430-7(Sep 1969).

Measurements are reported on the kinetics of the base-catalyzed detritiation of 2-carbethoxycyclopentanone over the temperature range 15 to 50°C. The catalysts were the solvent (water or deuterium oxide), chloroacetate ions and fluoride ions. The results for the water-catalyzed bromination of the proto-ester, obtained spectrophotometrically by observing the absorption band of bromine at 3,900 Å, are in good agreement with previously determined values. The detritiation results, taken in conjunction with the previously measured rates of deprotonation and dedeuteration, serve to confirm the original interpretation, that the results for proton transfer indicate a considerable tunnelling contribution, especially when the catalyst is the fluoride ion. The Swain correlation factor in this case is 1.32, whereas values higher than 1.44 are obtained for deuterium oxide and chloroacetate ion catalysis. These latter findings are accompanied by abnormal values of A_T/A_D and E_T-E_D and are discussed in terms of the mechanism of the reaction. [A = collision factor; E = activation energy]. (auth) (UK)

4283 PEROVSKITE COMPOUNDS OF THE TYPE $Ba_3MeU_2O_9$. Kemmler-Sack, Sibylle (Univ., Tuebingen, Ger.). Z. Naturforsch., 24b: 1398-1401(Nov. 1969). (In German).

The compounds $Ba_3MeU_2O_9$ (with Me = Mg, Mn, Fe, Co, Ni, and Zn) crystallize in a Perovskite lattice. Their spectroscopic properties as well as results of magnetic measurements on $Ba_3MnU_2O_9$ and $Ba_3FeU_2O_9$ are given. (tr-auth)

4284 SPECTROSCOPIC STUDY OF THE DIURANYL ION. Perrin, Andre; Prigent, Jacques (CNRS, Rennes, France). Bull. Soc. Chim. Fr.; No. 9, 3077-85(Sep 1969). (In French).

Visible fluorescence spectra of hydrated diuranyl chlorides, $U_2O_5Cl_2$ and $HU_2O_5Cl_3$, and hydrated diuranyl tetrachloride complexes $M_2U_2O_5Cl_4$ (M = Na, K, Rb, Cs) are reported. Classification of their fluorescence bands gives the various fundamental vibration frequencies in these compounds. The infrared absorption spectra of preceding compounds and anhydrous salts and complexes have also been determined in the range 400 to 200 cm^{-1}. The results are in good agreement with the hypothetical two $O \leftarrow U \rightarrow O$ groups joined by an oxygen bridge in all these compounds forming in this way a diuranyl ion $U_2O_5^{2+}$ of C_{2v} symmetry. (auth)

4285 TANDEM MASS-SPECTROMETER STUDY OF D_3O^+ AND SOLVATED DERIVATIVES. De Paz, M.; Leventhal, J. J.; Friedman, L. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys.; 51: 3748-61(1 Nov 1969).

The mass spectra of heavy water produced by electron impact on neutral gas at pressures up to 1 torr were studied in a tandem mass spectrometer. The enthalpies of hydration of solvated D_3O^+ as well as the deuteron affinity of D_2O were studied by measurement of kinetic-energy thresholds for the dissociation of the respective ions in collision with helium. Evidence was obtained for excited states in D_3O^+, $D_5O_2^+$, $D_7O_3^+$, $D_9O_4^+$, etc., which survived for time periods in excess of 10^{-4} sec. Efforts to de-excite these ions with neutral D_2O gas molecules in the high-pressure source were rarely successful, indicating difficulties in the interpretation of data based on the assumption of thermodynamic equilibrium in such ion sources. Values for the heat of association of two and three neutral heavy-water molecules were deduced from the threshold data. Relative cross sections for the attenuation of various ionic species were measured. The significant differences in the attenuation cross section point up problems in sampling steady-state concentrations of ions in a high-pressure ion source. The relative attenuation cross sections were used to test the validity of a point-charge–dipole interaction model for calculation of hydration enthalpies in the water systems. This model was shown to provide a very simple means of demonstrating an excellent correlation between experimentally determined enthalpies and cross-section data. (auth)

4286 THE VIBRATIONAL SPECTRA AND STRUCTURE OF DIMETHYL DITELLURIDE AND DIMETHYL DITELLURIDE-d_6. Sink, Charles W.; Harvey, Albert B. (Naval Research Lab., Washington, D. C.). J. Mol. Struct.; 4: 203-14(Oct 1969).

The infrared spectra of dimethyl ditelluride and dimethyl ditelluride-d_6 were recorded from 4000 to 33 cm^{-1}. The helium–neon excited Raman spectra of the liquids, neat, in benzene and in carbon tetrachloride solution, were also recorded. Unfortunately, the dark red color of the materials was responsible for considerable absorption of the exciting light and no depolarization values were measured. The weak Raman spectra together with the infrared data suggest a hydrogen-peroxide type structure (C_2 symmetry). All fundamental vibrational modes except the methyl torsional motions and a skeletal bending vibration were accounted for and the assignments are substantiated by a normal coordinate analysis. (auth)

4287 SOME HYDRATES OF URANYL CHROMATE(VI). Bouaziz, Roger; Carpentier, Jean-Marie (Faculte des Sciences, Rouen). Compt. Rend., Ser. C; 269: 833-6(13 Oct 1969). (In French).

A partial study of the binary system water–uranyl chromate(VI) gave evidence for five hydrates at 6, 5.5, 5, 4, and 2 moles of water of which four are new. A reported trihydrate was not found in this work. Most of the hydrates could be identified by radiocrystallographic examination. (tr-auth)

4288 AN X-RAY STUDY OF THE DECAY OF SOLID SOLUTIONS WITH ZIRCONIUM DIOXIDE BASE. Gavrish, A. M.; Sukharevskii, B. Ya.; Zoz, E. I.; Krivoruchko, P. P. (Ukrainian Scientific-Research Inst. of Refractory Materials, Kharkov. Physical-Technical Inst., Kharkov). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1584-8(Sep 1969). (In Russian).

The process of decomposition in solid solutions of ZrO_2-CaO, ZrO_2-MgO, and $ZrO_2-Y_2O_3$ was studied at 1200 to 2300°C in air and in an inert atmosphere. Temperature maxima of decomposition for all of the cubic solid solutions studied were determined. In ZrO_2-CaO and $ZrO_2-Y_2O_3$ the most intense decomposition occurs at about 1400°C, and in ZrO_2-MgO at about 1200°C. The initial mixtures of cubic and monoclinic solid solutions decompose more readily. The degree of decomposition of solid solutions in the system ZrO_2-MgO, in contrast to that in the ZrO_2-CaO system, increased with an increase in Mg ion concentration. In argon at 2000°C solid solutions of ZrO_2-MgO were almost completely decomposed, because of intense evaporation of MgO from the solid solution. (tr-auth)

4289 FAST REACTIONS OF COMPLEXES FORMED BY RARE EARTH ELEMENTS OF YTTRIUM SUBGROUP AND XYLENE ORANGE WITH TRILON B. Zhuchenko, E. P.; Budarin, L. I.; Yatsimirskii, K. B. (Inst. of General and Inorganic Chemistry, Kiev). Teor. Eksp. Khim., 5: 507-10(Jul-Aug 1969). (In Russian).

Kinetics of the reactions of the complexes that were formed by rare earth elements of the yttrium subgroup and Xylenol Orange with Trilon B were studied by a method that involved sudden disruption of the jet. The effects of acidity and temperature on the rate of reaction were determined. Rate constants and energy of activation were calculated. A mechanism of interaction is proposed. (tr-auth)

4290 SYNTHESIS OF PURE TRICHLORIDE OF ZIRCONIUM. Troyanov, S. I.; Tsirel'nikov, V. I.; Komissarova, L. N. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 12: 851-4(1969). (In Russian).

The trichloride of zirconium was synthesized by the reaction of metallic Zr with $ZrCl_4$ at 550°C and a pressure of 60 atm in a rotated autoclave. The product was 98.5% pure. The main impurity was metallic zirconium. Coarsely crystalline 99.5% pure $ZrCl_3$ was obtained in an autoclave on the reaction of Zr powder with $ZrCl_4$ at 550°C. The vapor pressure of the $ZrCl_4$ was 60 atm. (tr-auth)

4291 DIFFUSION-CONTROLLED AND CONCERTED BASE CATALYSIS IN THE DECOMPOSITION OF HEMITHIOACETALS. Barnett, Ronald E.; Jencks, William P. (Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc.; 91: 6758-65(19 Nov 1969).

Rate and equilibrium constants are reported for the reactions of benzenethiol, p-nitrobenzenethiol, and thioacetic acid with acetaldehyde to form the corresponding hemithioacetals. The hydroxide ion-catalyzed breakdown of these hemithioacetals occurs with rate constants near 10^{10} M^{-1} sec^{-1} and is largely or entirely limited by the rate of diffusion-controlled encounter of the substrate and catalyst. The energy of activation is 2 to 3 kcal/mole and the solvent deuterium isotope effect k_{OH^-}/k_{OD^-} is 1.25. In the synthesis reaction, formation of the carbon–sulfur bond and proton transfer occur rapidly and separation of hydroxide ion from the hemithioacetal is the rate-determining step. Weaker bases catalyze the breakdown reaction at a slower rate with a Brønsted slope β of 0.8 ± 0.03. This indicates that carbon–sulfur bond formation or cleavage and proton transfer are in some sense concerted. Equilibrium constants for hemithioacetal formation are independent of the acidity of the thiol over a range of acidity of 10^7. (auth)

4292 CARBOXYL CARBON ISOTOPE EFFECT ON THE ENZYMATIC DECARBOXYLATION OF GLUTAMIC ACID. O'Leary, Marion H. (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc.; 91: 6886-7(19 Nov 1969).

The carboxyl ^{13}C isotope effects on the decarboxylation of glutamic acid catalyzed by an enzyme from E. coli were measured The isotope effects were found to be $k^{12}/k^{13} = 1.0172$ at 37°C, pH 4.7. (D.H.M.)

4293 ELECTROCHEMICAL BEHAVIOUR OF $NpO_2(VI)$ AND $NpO_2(V)$ IN MOLTEN LiCl–KCl. Martinot, L.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Inorg. Nucl. Chem. Lett.; 5: 909-19(Nov 1969).

A chronopotentiometric study of the reactions $NpO_2(VI) + 2\ e^- \rightarrow NpO_2$ and $NpO_2(V) + e^- \rightarrow NpO_2$ is reported. At 400°C, the diffusion coefficient of $NpO_2(VI)$ is $(2.0 \pm 0.2)10^{-6}\ cm^2 \cdot sec^{-1}$ and that of $NpO_2(V)$ is $(4.8 \pm 0.45) \cdot 10^{-6}\ cm^2 \cdot sec^{-1}$. The standard potential $F^0_{NpO_2(V)/NpO_2} - E^0_{Cl_2/2Cl^-}$ was found equal to (0.119 ± 0.002) volt at 400°C. (auth) (UK)

4294 THE OXIDATION OF WATER BY Np(VII) IN AQUEOUS PERCHLORIC ACID MEDIA. Sullivan, J. C.; Zielen, A. J.

(Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett.; 5: 927-31(Nov 1969).

The existence of a 7+ oxidation state of Np in basic solution was reported, but there is less evidence available concerning the Np(VIII) species in acidic media. Some results of observations on the heptavalent Np ion in aqueous perchloric acid–perchlorate media are reported. The kinetic data reported for the reduction of Np(VII) to Np(VI) by water in aqueous perchloric acid–lithium perchlorate media are consistent with the following conclusions: (a) The reaction proceeds by two parallel paths; one path is first order in Np(VII) and the other is second order in Np(VII); (b) the path first order in Np(VII) is first order in [H^+]; (c) there is no strong evidence for the participation of perchloric ion in either path. (UK)

4295 INDIRECT NUCLEAR SPIN COUPLING IN METHYL, SILYL, AND HYDRIDE COMPOUNDS OF GROUP IV. Pfisterer, G.; Dreeskamp, H. (Univ., Stuttgart). Ber. Bunsenges. Phys. Chem.; 73: 654-61(Oct 1969). (In German).

The indirect spin coupling constants were determined by double resonance with signs relative to $^1J_{CH} > 0$ in the following group VI compounds: $O(CH_3)_2$, $S(CH_3)_2$, $Se(CH_3)_2$, $Te(CH_3)_2$, $Se_2(CH_3)_2$, $Te_2(CH_3)_2$, $(CH_3)SeTe(CH_3)$, $O(SiH_3)_2$, $S(SiH_3)_2$, $Se(SiH_3)_2$, CH_3OH, CH_3SH, CH_3SeH and SeHD. The reduced constants $^1K_{XC}$ and $^1K_{XSi}$ are negative (X = ^{77}Se and ^{125}Te) while $^1J_{SeH}$ and $^1K_{SeTe}$ are positive ($^1J_{SeTe} = -169$ Hz). The increase of $|^1K|$ with increasing atomic number of the coupling nuclei was interpreted by the increase of the nuclearspin-electronicspin contact term. $^2J_{HD}$ was negative in SeHD as was $^2J_{CH}$ in the CH_3XH compounds, while $^2K_{XH}$ was positive in all cases. The vicinal constants $^3J_{HH}$, $^3J_{CH}$ and $^3K_{SiH}$ were all positive with $^3J_{CH}$ decreasing with increasing atomic number of the intervening atom. Values of $^4J_{HH}$ range from 0 to +0.7 Hz. The absolute values of $^2J_{CC}$ decrease from 2.4 Hz in $O(CH_3)_2$ to 0.2 Hz in $Te(CH_3)_2$. $^1J_{SeH}$ depends relatively strongly on temperature, concentration and isotopic substitution. Using these experimental data, the mechanism of indirect spin coupling is discussed. In some cases a positive secondary isotope effect on the chemical shift of ^{1}H, ^{77}Se, and ^{125}Te by ^{2}H and ^{13}C substitution was observed. (auth)

4296 SOLVATION ENTHALPIES OF VARIOUS IONS IN WATER, PROPYLENE CARBONATE, AND DIMETHYL SULFOXIDE. Krishnan, C. V.; Friedman, Harold L. (State Univ. of New York, Stony Brook). J. Phys. Chem.; 73: 3934-40 (Nov 1969).

Data, previously surveyed, have been considerably extended by new determinations of heats of solution in propylene carbonate (PC), dimethyl sulfoxide (DMSO), water, and D_2O. It was found that the enthalpy of transfer of the R_4N^+ ions to PC from DMSO comprises additive contributions from the CH_2 groups, and these CH_2 terms are the same as those for the PC ← DMSO transfers of the primary alcohols. This is the basis of a simple method to get single-ion contributions to enthalpies of transfer of the electrolytes. In this way it was found that the enthalpy of transfer of Ph_4As^+ is the same as that of Ph_4B^-, just as has often been assumed for other solvent pairs. The enthalpies of the PC ← DMSO transfer of the alkali metal ions were an order of magnitude larger than would be expected from the Born charging equation. These large effects seem to reflect the difference in basicity of the two solvents. The enthalpy of transfer of the R_4N^+ ions to PC from water was dominated by an effect which does not comprise additive contributions from the methylene groups. Indeed, it reached a maximum value (as a function of chain length) as tetraamylammonium ion. This effect was attributed to structural changes ("icebergs") in the water in the neighborhood of the ions in aqueous solution. Part of the evidence for this interpretation is the finding that the nonadditive effect is 5% larger in D_2O than in H_2O, just as for the corresponding term in the hydration of the primary alcohols. (auth)

4297 DIOXOURANIUM(VI) COMPLEXES OF SCHIFF BASES OBTAINED FROM SUBSTITUTED SALICYLALDEHYDES AND ALKYL AMINES. Yamada, Shoichiro; Takeuchi, Akira (Osaka Univ.). Bull. Chem. Soc. Jap., 42: 2549-51(Sept. 1969).

Dioxouranium(VI) complexes have been examined with Schiff bases obtained from substituted salicylaldehydes and alkyl amines. Many new complexes of the type abbreviated as $UO_2(NO_3)_2(X\text{-SAL}\cdot R\cdot H)_2$ have been prepared as orange-red crystals. The notation X denotes H, 5,6-benzo and 3-CH_3O, and R represents alkyl groups. Infrared spectra indicate that there is no uncoordinated nitrate ion, and that the nitrate ions are coordinated with the uranium(VI) ion as unidentate ligands in these complexes. It is to be noted that the molecules, and not anions, of the Schiff bases are coordinated with the metal ions, as in many other dioxouranium(VI) complexes. (auth)

4298 STUDIES OF ACTINIUM(III) IN VARIOUS SOLUTIONS. III. ACTINIUM(III) COMPLEXES WITH OXALATE, SULFATE, CHLORIDE, AND THIOCYANATE IONS IN PERCHLORATE MEDIA. Sekine, Tatsuya; Sakairi, Mitsuo (Tokyo Univ.). Bull. Chem. Soc. Jap., 42: 2712-13(Sept. 1969).

Studies were made on the complex formation of Ac(III) in these aqueous systems in order to obtain further information about the stability of the complexes of trivalent lanthanides and actinides. The Ac(III) complexes were found to be more stable in the order: thiocyanate chloride sulfate oxalate. The oxalate complexes of Ac(III) were less stable than those of the other metal ions. No very remarkable differences were observed among the sulfate or chloride complexes of Ac and those of the other ions. The thiocyanate complexes of Ac(III) were much weaker than those with the other ions. It is generally assumed that the Ac(III) ion forms the least stable complexes among the trivalent metal ions, such as La, Eu, Lu, and Am, because it is the largest and the least basic ion. (P.C.H.)

4299 PRIMARY KINETIC ISOTOPE EFFECT FOR PHENYLATION WITH PHENYL RADICAL. Kobayashi, Michio; Minato, Hiroshi; Kobori, Nobumasa (Tokyo Metropolitan Univ.). Bull. Chem. Soc. Jap., 42: 2738(Sept. 1969).

A primary kinetic isotope effect was observed in the homolytic phenylation of aromatic compounds, such as $C_6H_6-C_6D_5NO_2$, $C_6H_5NO_2-C_6D_5NO_2$, and m-dinitrobenzene-d_5. The experimental procedure is described. A mechanism, in which the addition of phenyl radical is reversible, is proposed for the reaction. (P.C.H.)

4300 EFFECT OF DEUTERIUM EXCHANGE OF SILICA GEL ON DIELECTRIC RELAXATION. Muroya, Masa-aki (Osaka Electro-Communication Univ.); Kondo, Seiichi. Bull. Chem. Soc. Jap., 42: 2724-5(Sept. 1969).

Studies were made on the dielectric relaxations (designated as Dispersion I′ and II′) and one anomaly (Anomaly III′) of deuterated silica gel. The results showed that the activation energies ΔE increased and constants τ_0 decreased by deuterium exchange. (P.C.H.)

Radiation and Nuclear Chemistry

Refer also to abstract 4560.

4301 (AD–691327) HYDROGEN AND HYDROGEN PEROXIDE PRODUCED BY GAMMA RADIOLYSIS OF OXYGEN-SATURATED WATER. Sasse, Ronald A. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Jun 1969. 38p. (NDL-TR-122). CFSTI.

Pure, oxygen-saturated water was irradiated with ^{60}Co gamma radiation. At low doses, G (H_2O_2) was 2.6. At doses greater than 2000 Rad, G (H_2O_2) was 1.33. Over the entire dose interval G (H_2) was constant at 0.17. The G values of 1.33 and 0.17 agree with published data. Many experiments are presented to form the argument that G (H_2O_2) = 2.6 is not the result of an impurity reaction and that this value is the initial yield. This high G value was measured by two different purification procedures. The results are compared with the presently accepted mechanism for the radiolysis of oxygen-saturated water and the conclusion is reached that this mechanism is in error at least in the low dose range. Another mechanism is developed to account for the experimental results where H_2O (+) and e (–) are proposed as the primary species in the radiolysis of water. (auth) (USGRDR)

4302 (BNL–14158) PURIFICATION OF OZONE FROM A CHEMONUCLEAR REACTOR. Steinberg, M.; Beller, M. (Brookhaven National Lab., Upton, N. Y.). Oct 1969. 11p. Dep. CFSTI.

A process for removal of fission products from a chemonuclear process stream containing ozone and for recovery of ozone was developed and designed, and capital and power costs estimated for a plant purifying 400 tons per day ozone. (auth)

4303 (NYO–910–124) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 4. CYCLOTRON FACILITY AND RADIONUCLIDE PRODUCTION. Progress Report, May 1, 1968–May 1, 1969. Laughlin, John S.; Tilbury, Roy S.; Mamacos, James P. (Sloan-Kettering Inst. for Cancer Research, New York). Sept. 30, 1969. Contract AT(30-1)-910. 25p. Dep. CFSTI.

Sixty-five production runs of fluorine-18 in isotonic saline were made, and the chemical form of the ^{18}F in the product solution was investigated. A method was developed for the production of ^{18}F-labeled potassium fluoroborate. Several methods for the production of ^{123}I were investigated. A method involving the ^{3}He irradiation of enriched ^{122}Te, separating ^{123}Xe and allowing this to decay to ^{123}I is being developed. A method for the production of ^{52}Fe as ferrous citrate was completed. A method for the production of ^{48}Cr as sodium chromate is being studied. The production of ^{81}Rb, ^{82m}Rb, and ^{81m}Kr was investigated using ^{3}He particles on sodium bromide, and the yields obtained were compared with the ^{4}He particle yields. The preparation of some ^{11}C-labeled organic compounds by recoil labeling was investigated. Five additional target chambers were designed and constructed: an internal target probe for irradiating solids in the internal beam; a cooled foil holder to enable the extracted beam to irradiate targets in air; spinning wheel target so that twelve targets can be irradiated simultaneously at the same beam current; and two versions of a target chamber designed for the irradiation of powder or granular targets, whereby the radionuclide produced can be removed by continuous gas flow. These two versions are used for the production of iodine-123 and nitrogen-13. (auth)

4304 IMPROVEMENTS IN OR RELATING TO THE CROSS-LINKING OF ETHYLENE POLYMERS. **(to General Electric Co.). British Patent 1,165,669. Oct. 1, 1969. Priority date Jan. 17, 1966, United States.**

Ethylene polymers are crosslinked by adding 0.1 to 40 wt % of an epoxidized polyolefin and subjecting the mixture to high-energy electrons to generate free radicals for the crosslinking. (B.L.M.)

4305 PROCESS AND APPARATUS FOR THE PRODUCTION OF IRRADIATED ARTICLES. **Derbyshire, Rodney Lamkin; Schernig, Fred Warner (to Raychem Corp.). British Patent 1,165,267. Sept. 24, 1969. Priority date Mar. 3, 1966, United States.**

A method and apparatus are provided for producing polymeric tubing that has the property of elastic memory. The polymeric material is formed by extrusion, and a wire is provided adjacent to or in contact with the internal surface of the tube to provide a charge bleed to ground for any charge that may build up within the tube during irradiation with electrons to crosslink the polymeric material. (B.L.M.)

4306 THE RADIATION CHEMISTRY OF SOLUTIONS OF P_4 IN CCl_3Br: THE FORMATION OF DIPHOSPHINES. Airey, P. L. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 24b: 1393-7(Nov. 1969).

The diphosphines $CCl_3(Br)P_2(Br)CCl_3$ and $CCl_3(Br)P_2Br_2$ are formed when solutions of P_4 in CCl_3Br are exposed to ionizing radiation or maintained at 100°C for an hour. The radiation chemical yields (G values) are respectively 230 and 170 at RT. No "red" phosphorus is formed. The diphosphines react with Br_2 to form CCl_3Br; with Cl_2 to form CCl_3Br, Br_2 and PCl_3; and with EtOH to form $CCl_3P(OEt)_2$ and $CCl_3P(H)(O)(OEt)$. (auth)

4307 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: RADIATION DOSE AND OPTICAL ROTATION. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Appl. Polym. Sci., 13: 2265-8(Nov. 1969).

When protein was irradiated by gamma rays from a ^{60}Co source, an activated state on the position of the groups in the vicinity of the asymmetric carbon atoms in the protein molecule was caused. An empirical equation for the change in optical rotation was obtained, and the phenomena were explained on the basis of the molecular mechanism. The general equation for the change in optical rotation is given by $|\alpha| = (b + a \log R)(1 - e^{-kt})$, where $|\alpha|$ is the specific rotation of the solution, R is the gamma radiation dose, t is time, and a, b, and k are adjustable constants. (auth)

4308 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF PROTECTORS ON THE BREAKING OF SECONDARY BONDING IN PROTEIN. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Appl. Polym. Sci., 13: 2293-6(Nov. 1969).

The radiation protective effect of the breaking of secondary bonding in protein was examined with sodium benzoate, monosodium 1-glutamate, 1-arginine, and thiourea, and the behavior of viscosity against the protector was obtained. An experimental equation for the viscosity change is given by $\eta\text{red} = b - a \log X$, where ηred is the reduced viscosity of the solution, X is the protector concentration, and a and b are adjustable constants. (auth)

4309 UNSTABLE INTERMEDIATES. PART LXVI. ELECTRON SPIN RESONANCE STUDY OF RADIATION PRODUCTS IN γ-IRRADIATED ALKALI BOROHYDRIDES: THE RADICALS HBO^- AND BH_3^-. Catton, R. C. (Univ. of Leicester, Eng.); Symons, M. C. R.; Wardale, H. W. J. Chem. Soc., A; 17: 2622-6(1969).

The ESR spectra of γ-irradiated alkali borohydrides were analyzed in terms of the formation of BH_3^- and HBO^-, the latter being formed, presumably from partially hydrolyzed anions. Both radicals appear to be freely rotating at 77°K, but HBO^- gives an anisotropic spectrum at about 20°K which was analyzed to give the g-tensor and approximate A-tensor for ^{11}B. The results for BH_3^- were compared with those for the isoelectronic species CH_3 and NH_3^+, and those for HBO^- with HCO and HCN^-. (auth) (UK)

4310 PULSE RADIOLYSIS. **Boog, J. W. (London Univ.). Proc. Roy. Inst. Gt. Brit.: 42: 215-36(1969).**

A discourse on this aspect of radiation chemistry at the Royal Institution, London, on Feb. 23rd, 1968 is reproduced. (UK)

4311 UNSTABLE INTERMEDIATES. PART LXIV. A COMPARISON BETWEEN THE REACTIONS OF ATOMIC HYDROGEN WITH SOME SUBSTITUTED BENZENES AND THOSE INDUCED BY γ-IRRADIATION. Campbell, D.; Symons, M. C. R.; Verma, G. S. P. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 16, 2480-2(1969).

The ESR spectra of radicals obtained by reactions between hydrogen atoms and a range of substituted benzenes are compared with those obtained from the γ-irradiated materials. The most significant feature of these results is the formation of cyclohexadienyl radicals. While in many cases these radicals were formed by both processes, certain compounds, such as para-substituted benzoic acids, only gave these radicals on bombardment with hydrogen atoms, whereas others, such as resorcinol and biphenyl, gave good yields only on exposure to γ-rays. No example of addition at the substituted site was found, addition being ortho or para to all substituents. Addition to 1,3-disubstituted compounds was far more effective than to either 1,2- or 1,4-disubstituted compounds. Loss of tertiary hydrogen by both processes occurred for cumene and cumic acid. (auth) (UK)

4312 UNSTABLE INTERMEDIATES. PART LXV. ELECTRON SPIN RESONANCE STUDIES OF RADICALS DERIVED FROM PROTONATED ALCOHOLS BY γ-IRRADIATION: THE RADICALS $R_2COH_2^+$. Brimage, D. R. G.; Cassell, J. D. P.; Sharp, J. H.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 17, 2619-21(1969).

Solutions of methanol or isopropyl alcohol in concentrated sulphuric acid on exposure to γ-rays at 77°K gave comparable yields of the radicals $\dot{C}H_3$ and $\dot{C}H_2OH_2^+$ (from $CH_3OH_2^+$) and $(CH_3)_2\dot{C}H$ and $(CH_3)_2\dot{C}OH_2^+$ [from $(CH_3)_2CHOH_2^+$]. The former are formed by dissociative electron capture. The latter are of interest since the results indicate that the unpaired electrons are almost entirely localized on carbon, and that the large coupling of about 5 G to the oxygen protons probably arises by a hyperconjugation mechanism. (auth) (UK)

4313 THE EFFECT OF OXYGEN ON THE IONIC REACTIONS IN γ-IRRADIATED METHANE–PROPANE MIXTURES. Clay, P. G.; Siddiqi, A. A. (Imperial Coll. of Science and Tech., London). J. Chem. Soc., D; No. 21, 1271(1969).

It was found that methane oxidation products react with the ionic precursors of ethane in irradiated methane–oxygen–propane systems. (auth) (UK)

4314 HIGH-FIELD CONDUCTION IN POLYETHYLENE. **Tanaka, Toshikatsu (Central Research Inst. of Electric Power Industry, Tokyo); Inuishi, Yoshio. Denki Gakkai Zasshi, 89-4: 673-82(Apr. 1969). (In Japanese).**

The effects of electron irradiation on electronic conduction of polyethylene in high electric field are reported. PE films of about 40μ thick on which Au was evaporated in vacuo were used as electrode and the dark current and photo current due to light projection from a Xe lamp were measured in a field of 10^2 to 10^4 both with and without irradiation by 1.5-MeV electrons. Electron irradiation in the dark remarkably increased the electric conductivity, and the electric conductivity was proportional to the square root of the field intensity. At 500 to 1000, the dark currents in nonirradiated PE did not obey Ohm's law, but when PE was irradiated, the law was obeyed. Electron-irradiated PE showed a very large value of steady photo-current by Xe light compared with that of the non-irradiated PE. The changes in electric conductivity may be explained by a combination of electron variation phenomena by the donor and the carrier trap, Poole-Frenkel's effect, and the influences of space charge. (NSA of Japan)

4315 CHEMICAL REACTIONS OF ADSORBATES ON GAMMA-IRRADIATED SILICA GEL; YIELDS AND PROPERTIES OF ELECTRONS, REACTIVE CENTERS, FREE RADICALS, AND ION RADICALS. **Wong, Pak Kuen. Madison, Wis., Univ. of Wisconsin, 1969. 157p.**

Thesis.

Studies were carried out on reactions of γ-irradiated silica gel with adsorbates added before and after irradiation to obtain information about reactive centers stabilized in the gel during irradiation and about the transfer of electrons from the gel to adsorbates present during irradiation. Gamma irradiation in the absence of an adsorbate produces an ESR singlet attributable to trapped electrons

having a radiation G value of about 0.05. The thermal stability and microwave power-saturation characteristics of this species have been investigated. Irradiation also produces nonparamagnetic reactive centers, with G values of a few tenths. Silica gel containing sorbed alkyl halides produces alkyl radicals when irradiated at 77°K, as a result of dissociative electron capture. Other adsorbates include galvinoxyl, CO_2, SO_2, benzene, biphenyl and naphthalene; all scavenge electrons produced from the gel during irradiation. Galvinoxyl forms the nonparamagnetic anion and others form paramagnetic anion radicals. The G values of these products (two to four for the alkyl halides, galvinoxyl and the aromatics), and the fact that its values are independent of adsorbate concentrations from 10^{-2} to 10^{-6} mole fraction, require that electrons ejected from the irradiated silica gel migrate extensively on the surface and are efficiently captured by the adsorbates. Other reactions of adsorbates present during irradiation include the formation of cyclohexadienyl radicals (C_6H_7) and a species attributable to the dimeric anion radical $(C_6H_6)_2^-$ from benzene present at 10^{-2} mole fraction. Nitrobenzene forms $C_6H_6^-$ and C_6H_5, the distribution of which depends on sorbate concentration. When silica gel containing both CH_3Br and galvinoxyl is irradiated, G(-galvinoxyl) ranges from 5 to 18, depending on the halide concentration. CH_3Cl exerts a similar, although smaller, effect. Silica gel fractured under a vacuum contains paramagnetic species, which react with NO and are attributed to electrons created by the homolysis of Si–O bonds. These reactions were studied at 77 or 300°K by ESR spectroscopy and by optical absorption. The optical spectra are used to complement the ESR spectra in identifying the species produced. Davison, Purified Grade, silica gel having a BET surface area of about 600 m^2g^{-1} after dehydration at 460°C was used. (Diss. Abstr. Int., B)

4316 IRRADIATED POLY(ETHYLENE OXIDE) AND PROCESS THEREFOR. **King, Paul A. (to Union Carbide Corp.). U. S. Patent 3,470,078. Filed July 31, 1967.**

Water-soluble homopolymers, copolymers, and terpolymers of polyethylene oxide irradiated by exposure to ioning radiation in a total dose between about 0.01 and about 5 Mrad have a reduced viscosity value of at least 1.1. Aqueous solutions of the irradiated polymer are characterized by viscosities at least 10% lower than aqueous solutions of an otherwise identical but unirradiated polymer and by a marked decrease in pituitousness and by relatively small changes in viscosity compared to aqueous solutions of an otherwise identical but unirradiated polymer at the same concentration and temperature. (Offic. Gaz.)

4317 HIGHLY RADIATION-SENSITIVE TELOMERIZED POLYAMIDES. **D'Alelio, Gaetano F. (to PPG Industries, Inc.). U. S. Patent 3,471,386. Filed May 18, 1966.**

A method is described for the production of highly radiation-sensitive telomerized diacrylyl polyamides by subjecting the polyamides to high-energy ionizing radiation so as to produce three-dimensional crosslinked, insoluble, infusible polymers at relatively low radiation doses. (Offic. Gaz.)

4318 PULSE-RADIOLYSIS STUDY OF SOME UNSTABLE COMPLEXES OF IRON. **Jayson, G. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.): Keene, J. P.: Stirling, D. A.: Swallow, A. J. Trans. Faraday Soc.: 65: 2453-64(Sep 1969).**

Pulse radiolysis of oxygen-containing solutions of ferrous perchlorate in perchloric acid (1 $\underline{M}$) enabled the formation and disappearance of a ferrichydroperoxide complex, $Fe^{3+}HO_2^-$, to be observed. The rate constant for its formation by reaction of HO_2 radicals with free ferrous ions is $2.1 \pm 0.4 \times 10^6\ M^{-1}s^{-1}$ in the pH range 0 to 2.1. The complex disappears in a first-order reaction with a rate constant independent of pH in the range 0 to 2.1. It exhibits a broad absorption in the region 280-600 nm, with $\epsilon_{430nm} = 280 \pm 30\ M^{-1}\ cm^{-1}$. In the absence of oxygen a different absorbing species can be seen, attributed to a ferric hydride complex, $Fe^{3+}H^-$. This is formed by the reaction of hydrogen atoms with free ferrous ions with $k = 7.5 \pm 2 \times 10^6\ M^{-1}\ s^{-1}$. It disappears by reaction with hydrogen ions, with $k = 1.06 \pm 0.1 \times 10^4\ M^{-1}\ s^{-1}$. Its absorption spectrum exhibits a maximum at 325 nm, and $\epsilon_{325} = 650 \pm 65\ M^{-1}\ cm^{-1}$. (auth) (UK)

4319 RADIATION GRAFTING OF MONO- AND DI-ACRYLATES OF LOWER POLYHYDRIC ALCOHOLS AND POLYHYDRIC ALCOHOL ETHERS TO COTTON AND WOOL. **Timmerman, Robert (to Radiation Processing Inc.). U. S. Patent 3,467,488. Filed May 16, 1962.**

A process is described for rendering cotton and wool fibers water-repellant and shrink-resistant. The fibers are immersed in an aqueous emulsion of a water-insoluble acrylic ester monomer selected from the group consisting of the mono and diacrylates and methacrylates of lower polyhydric alcohols and polyhydric alcohol ethers containing from 1 to 8 carbon atoms. The fibers and monomers are then subjected to high-energy radiation having an intensity between 0.25 and 5.0 Mrad for a period of about 1 to 10 sec to effect graft polymerization of the monomers on the fibers. (Offic. Gaz.)

4320 RADIATION CHEMISTRY OF THE AQUEOUS NITRATE SYSTEM. II. SCAVENGING AND pH EFFECTS IN THE ^{60}Co γ RADIOLYSIS OF CONCENTRATED SODIUM NITRATE SOLUTIONS. Daniels, Malcolm; Wigg, Eric E. (Oregon State Univ., Corvallis). J. Phys. Chem.; 73: 3703-9(Nov. 1969). (RC-2014-2).

Scavenging studies with H_2, 1-propanol, nitrite, and iodide ions at neutral pH indicate that H_2 and 1-propanol react only with available OH radicals; g(OH) decreases with increasing nitrate concentration. Nitrite scavenging shows only minor amounts of O atom, and I^- interferes in the "direct" process. At alkaline pH, changes in yields are consistent with (a) the dilute solution mechanism involving H_2O_2 and (b) an effect of pH on the "direct" process. Scavenging studies at pH 9 (H_2, and NO_2^-) and pH 12 (1-propanol) show yields of OH and O unchanged from neutral solution. A mechanism is proposed for the direct radiolysis, $NO_3^- \xrightarrow{\gamma} (NO_2 + O + e)_{cage, spur}$; $O + NO_3^- \rightarrow O_2 + NO_2^-$, and is discussed in relation to pulse radiolysis and uv photolysis studies. (auth)

4321 RADIATION CHEMISTRY OF THE AQUEOUS NITRATE SYSTEM. III. PULSE ELECTRON RADIOLYSIS OF CONCENTRATED SODIUM NITRATE SOLUTIONS. **Daniels, Malcolm (Oregon State Univ., Corvallis). J. Phys. Chem.; 73: 3710-17 (Nov 1969). (RC–2014–6).**

Optical absorption spectra and reaction kinetics of transient species in concentrated sodium nitrate and nitric acid solutions were investigated for 0.5 to 6 $\underline{M}$ $NaNO_3$ and 6×10^{-2} to 9 $\underline{M}$ HNO_3. NO_3 was identified as a transient in concentrated neutral nitrate solutions and is shown to be characteristic of the "direct effect." Yield of NO_3 is constant from pH 4 to 11; it decays by first-order kinetics strongly dependent on pH. In neutral solution NO_2 is identified; it decays by second-order kinetics with $2k/\epsilon = 1.4 \times 10^5$. NO_2 is also produced by the "direct" effect, and as the yield of NO_3 is intensity-dependent, a mechanism of formation is probably $O + NO_2 \rightarrow NO_3$. In acid solutions, NO_3 is also formed by an "indirect effect" with a rate constant first order in NO_3^- and H^+. The reaction is probably $OH + NO_3^- + H^+ \rightarrow H_2O + NO_3$. The yield of NO_3 increases fourfold between pH 1 and 0, and the direct process may be pH dependent. In strongly acid solutions decay of NO_3 becomes second order with $2k/\epsilon = 2.8 \times 10^6$. $\epsilon(NO_3)/\epsilon(NO_2) = 0.5$ at 400 nm and $\epsilon(NO_3)_{670}/\epsilon(NO_3)_{400} = 2.9$ NO_2 is not observed in acid solutions. (auth)

4322 ABSORPTION SPECTRUM AND DECAY KINETICS OF O_2^- AND HO_2 IN AQUEOUS SOLUTIONS BY PULSE RADIOLYSIS. **Rabani, Joseph (Hebrew Univ., Jerusalem): Nielsen, Sigurd O. J. Phys. Chem.; 73: 3736-44(Nov 1969).**

The absorption spectrum and decay kinetics of O_2^- radical ions were investigated in H_2O_2 and $H_2 + O_2$ solutions by the method of pulse radiolysis. The peak absorption at 2400 to 2450 Å has an extinction coefficient of 1970 $\underline{M}^{-1}\ cm^{-1}$. In the pH range ~5 to 9.7, optical absorption assigned to O_2^- was observed. The decay of O_2^- absorption is consistent with $k_{(HO_2+O_2^-)} = 7.9 \times 10^7\ \underline{M}^{-1}\ sec^{-1}$, and $k_{(O_2^- + O_2^-)} < 10^5\ \underline{M}^{-1}\ sec^{-1}$. In the pH range below 5, absorption due to HO_2 was also observed. The extinction coefficient of HO_2 at 2400 Å was measured and equals 1150 $\underline{M}^{-1}\ cm^{-1}$. Using both data obtained and those of Bielski and Schwarz recently reported results, both sets of data were accounted with $k_{(HO_2+HO_2)} = 6.7 \times 10^5\ \underline{M}^{-1}\ sec^{-1}$. Both kinetic and spectroscopic results indicate that the pK of HO_2 radicals may be slightly higher than the previously reported value of 4.5, namely 4.8. (auth)

4323 TRAPPING OF FISSION XENON IN NEUTRON IRRADIATED UC. **Matzke, Hj.; Springer, F. (CCR–EURATOM, Ispra, Italy). Radiat. Eff.; 2: 11-18(Nov 1969).**

Data were obtained on the effect of total neutron dose and gas concentration on mobility and release of fission gases in UC, a question that is important for the swelling problem. UC powders with a carbon content of 4.68% were irradiated at reactor ambient temperature to doses between 1.5×10^{14} and 1.5×10^{19} nvt. The release of fission xenon was measured at a constant temperature of 1000°C. With increasing dose, a pronounced decrease with dose in the apparent diffusion coefficient was observed indicating trapping (i.e., gas-damage or gas-gas interactions). The kinetics of the release and the nature of the traps are discussed. The results are confirmed by additional data using UC single crystals that were labeled with xenon to different concentrations using ion bombardment techniques. The combined results yield a consistent picture of fission gas mobility and trapping in UC. (auth)

4324 THE ROLE OF SLOW ELECTRONS IN THE EFFECT OF ALCOHOLS ON THE γ-RADIOLYSIS OF ETHYLENE. **Hotta, H.; Kurihara, H.; Sugiura, T. (Japan Atomic Energy Research Inst., Takasaki, Japan). Radiat. Eff.; 2: 41-5(Nov 1969).**

When ethylene, containing a small amount of gaseous alcohol, was irradiated by gamma rays, the G($-C_2H_4$) had a maximum value at the addition of ethyl, isopropyl, or t-butyl alcohol less than 0.03 electron fraction. The total concentration of mixtures was 1.1×10^{-4} mole/cc. On the other hand, the appearance potential of negative ions, formed by dissociative-resonance-electron-capture processes of slow-electron impact, was measured by mass spectrometry. The lowest value for ethanol (2.7 eV) was much lower than that for ethylene (7.9 eV). This fact suggests that slow electrons in the system are more or less captured by alcohols added to retard the neutralization of positive ethylene ions. The enhancement of the ethylene consumption by adding alcohols is, therefore, attributed to the ion-molecule reactions, that is, the ionic polymerization of ethylene. (auth)

4325 RADIOCHEMICAL PURITY OF SHORT-LIVED ^{99m}Tc FROM COMMERCIAL SUPPLIERS. Crosby, E. H. (Guthrie Clinic, Sayre, Pa.). Radiology, 93: 435-9(Aug. 1969).

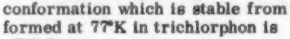
Routine shipments from two of the three commercial suppliers of separated instant ^{99m}Tc consistently contained ^{186}Re as the dominant radiochemical impurity during the summer and fall of 1968. A typical impurity level was 0.1 percent at time of administration to the patient. This produced increases of only a small percentage in dosages to the whole body and to critical organs. (auth)

4326 STRUCTURE OF FREE RADICALS IN TRICHLORPHON X-IRRADIATED AT ROOM TEMPERATURE. Lassmann, G.; Damerau, W.; Lohs, Kh. (Institut fuer Biophysik, Berlin). Z. Naturforsch., 24b: 1375-80(Nov. 1969). (In German).

The structure of radicals in x-irradiated polycrystalline phosphonic acid esters (trichlorphon-type) and trichlorphon single crystals was investigated by ESR. At room temperature in trichlorphon the radical $(RO)_2 > P(O) - CHOH - CCl_2$ ($R = CH_3$) is formed by removal of a chlorine atom. The g-factor is 2.010 and the hyperfine parameters are $\alpha_H{}^\beta = 7 \pm 0.5$ G for the isotropic β-proton and $\alpha_{Cl} = 7$ to 14 G for the two anisotropic chlorine atoms. The structure of this radical type is not influenced by a substitution of the methyl groups by larger alkyl groups ($R = C_2H_5$, C_3H_7, C_4H_9 etc.). ESR-spectra of some other irradiated insecticides are described. Difficulties in the analysis of ESR spectra of aliphatic radicals with chlorine-hyperfine structure (especially quadrupole-effects) are discussed. (auth)

4327 THE FORMATION AND CONVERSION OF PRIMARY RADICALS IN TRICHLORPHON IRRADIATED AT 77°K. Lassmann, G.; Damerau, W.; Lohs, Kh. (Institut fuer Biophysik, Berlin). Z. Naturforsch., 24b: 1381-4(Nov. 1969). (In German).

The formation and conversion of primary radicals in the irradiated phosphonic acid ester trichlorphon and some related compounds at 77°K were studied by ESR. The irreversible changes of spectra by annealing of the sample demonstrate that the chlorine-containing radical type $R\dot{-}CCl_2$ formed at room temperature represents a secondary type having a precursor with a short half-life in the form of a primary radical of similar structure but different conformation which is stable from 77°K to 245°K. A further radical formed at 77°K in trichlorphon is



$(\cdot CH_2O)(CH_3O)P(O)-CHOH-CCl_3$ with $g = 2.0036$, $\alpha_H = 20$ G and $\alpha_P = 9$G.

This type disappears at −60°C. In related compounds (DDVP and the acetic acid ester of trichlorphon) a similar radical $\dot{C}H_2OR$ is induced, which in contrast to trichlorphon is converted into an oxygen radical with $g_\perp = 2.0076$ and $g_{||} = 2.017$. (auth)

4328 EFFECT OF RADIATIONS ON POLYMERS IN SOLUTION: DEGRADATION OF POLYALKYLMETHACRYLATE OBSERVED WITH LIGHT SCATTERING. Maura, Giancarlo (Facolta d'Ingegneria, Rome). Ann. Chim. (Rome), 59: 604-16(July 1969). (In Italian).

The degradation of polymers treated with ionizing radiation in solution was examined to investigate radiation effects on molecular weights, on the dimensions and shape of macromolecules, and on the possible protective action of solvents. The effect of ^{60}Co γ rays on some polyalkylmethacrylate homologs (methyl-, ethyl-, n-butyl- and n-hexyl-polymethacrylates) in solutions of various organic solvents was studied by the light-scattering method. The weight-average molecular weights, M_p, were calculated from light-scattering data by the Zimm method before and after irradiation. Among the polymeric homologs tested, those with the largest attached groups were the most sensitive to the degradative action of radiation. Among the solvents tested, benzene-containing mixtures had a protective effect against radiation. By extrapolation to the zero angle of the null concentration curve in the Zimm plots, the mean square radius of gyration, $\overline{r^2}$, and the number-average molecular weight, M_n, were calculated approximately. The degradation effect of γ rays, as shown by the marked diminution of molecular weights, was not accompanied by as large a decrease in molecular dimensions, as could be seen from the comparison of $\overline{r^2}$ values before and after irradiation. That is, it appeared that while the irradiation produced degradation of macromolecules, it also conferred on them a greater flexibility, so that, for the same molecular weight, the irradiated chains showed a degree of extension larger than that of nonirradiated chains. (BBB)

4329 THE SZILARD–CHALMERS REACTION ON GALLIUM PHTHALOCYANINE IN HIGH NEUTRON FLUX. Schwartz, A.; Rafaeloff, R.; Yellin, E. (Soreq Nuclear Research Centre, Yavne, Israel). Int. J. Appl. Radiat. Isotop.; 20: 853-7(Dec 1969).

The Szilard–Chalmers process on gallium phthalocyanine was studied at neutron fluxes of up to 2×10^{13} n/sec·cm^2. The yield, the enrichment factor, and the decomposition were studied as a function of extracting conditions and of radiation dose. The best extracting conditions were determined. The results indicate a possibility of obtaining increased enrichment factors by using a double extraction procedure. (auth) (UK)

4330 ESR STUDIES OF TRAPPED CO_2^- RADICALS IN X-IRRADIATED SUCCINIC ACID. Schwartz, Robert N.; Hanna, Melvin W.; Bales, Barney L. (Univ. of Colorado, Boulder). J. Chem. Phys.; 51: 4336-40(15 Nov 1969).

Studies of the g tensor of the singlet in x-irradiated succinic acid suggest that this line is due to the CO_2^- radical ion. Temperature-variation studies indicate that this CO_2^- fragment arises from the decomposition of the anionic species $[HOOCCH_2CH_2COOH]^-$, which appears to be formed in the initial radiation-damage process. A mechanism rationalizing the ESR data on all irradiated carboxylic acids is proposed. (auth)

4331 APPROACH TO THE CALCULATION OF HIGH-ENERGY DISPLACEMENT REACTION YIELDS. Baer, M.; Amiel, S. (Soreq Nuclear Research Center, Yavne, Israel). J. Amer. Chem. Soc.; 91: 6547-52(19 Nov 1969).

An attempt is made to calculate the reaction cross section for hot reactions of the type $ZY + X \rightarrow ZH + Y$, where X and Y are isotopes. For this purpose, a model is assumed which permits a simple (classical) treatment of the three interacting particles. The reaction cross section $\sigma(E)$ is obtained by averaging over initial conditions selected in a random manner, by the Monte Carlo method. The results are compared with those obtained by Karplus, et al., for reactions $H_2(D_2) + T \rightarrow H(D)T + H(D)$ and with experiment. In all cases a good fit is obtained. (auth)

4332 FORMATION OF EXCITED INTERMEDIATES IN RECOIL CARBON ATOM REACTIONS. PRESSURE-DEPENDENCE STUDIES IN THE GAS PHASE. Welch, Michael J.; Wolf, Alfred P. (Brookhaven National Lab., Upton, N. Y.). J. Amer. Chem. Soc.; 91: 6584-9(19 Nov 1969).

The variation in yield of carbon monoxide-^{11}C, acetylene-^{11}C, and ethylene-^{11}C from the reaction of recoil carbon atoms with methane, propane, cyclopropane, and neopentane was studied as a function of the hydrocarbon gas pressure. The hydrocarbons contained 4.5% added oxygen as scavenger. The total gas pressure was varied over a 1000-fold range in all cases except neopentane where the pressure range was varied 100-fold. In all cases studied the yield of carbon monoxide-^{11}C decreased with increasing pressure and yields of acetylene-^{11}C and ethylene-^{11}C increased with increasing pressure. A model is presented that invokes a collision complex being formed prior to carbene formation where the excited carbene then can fragment or react further to give the observed products. The nature of the collision complex is suggested as being responsible for the observed pressure dependency. (auth)

4333 STEREOSPECIFICITY OF RADIATION ACRYLONITRILE POLYMERIZATION FROM GASEOUS PHASE ON POLYETHYLENE. Vlasov, A. V.; Malakhova, L. I.; Tsetlin, B. L.; Shablygin, M. V. Vysokomol. Soedin., Ser. B; 11: 557-8 (Aug 1969). (In Russian).

Data are given on a method of radioinduced polymerization from the gas phase on solid bases for obtaining stereodistributed polyacrylonitrile molecules of monomer with high polarity. It was found that the radioinduced polymerization of acrylonitrile from the gas phase on stretched polyethylene films is orderly in character. The base determines the geometric orientation of the increase of the polymer chains and also the molecular monomer orientation during the addition to the growing polymer chain. (tr-auth)

4334 DETERMINATION OF MOLECULAR WEIGHT DISTRIBUTIONS OF DNA BY MEANS OF SEDIMENTATION IN A SUCROSE GRADIENT. van der Schans, G. P.; Aten, J. B. T. (National Defence Research Organization TNO, Rijswijk, Netherlands). Anal. Biochem.; 32: 14-30(15 Oct 1969).

When a polydisperse sample of DNA is sedimented through a sucrose gradient in a preparative ultracentrifuge and the concentration of DNA is measured as a function of sedimentation distance, the distribution of molecular weights in the sample can in principle be calculated if the relation between sedimentation coefficient and molecular weight is known. In order to avoid errors due to viscosity of the sample, distortion of the gradient during fractionation, loss of material on the wall of the centrifuge tube, etc., a number of precautions are necessary. These are systematically examined and a complete calibration of the method is reported for single- and double-stranded DNA. Furthermore, random breaks were introduced into a monodisperse sample of DNA by means of gamma irradiation and it is shown that the average number of single- or double-strand breaks per molecule can be calculated from the sedimentation distance corresponding to the maximum of the distribution of broken DNA in the gradient. (auth)

4335 RADIATION POLYMERIZATION OF TRIOXANE IN THE PRESENCE OF POLAR IMPURITIES. Sack, Henri; Sack, Berthe (to Houilleres du Bassin du Nord and du Pas de Calais). U. S. Patent 3,483,106. 9 Dec 1969. Priority date 24 Jan 1966, France.

A process was developed for the preparation of high-molecular-weight polyoxymethylene wherein polar impurities are admixed with trioxane, and mixture is subjected to high-energy ionizing radiation followed by heating to cause it to be polymerized. (Offic. Gaz.)

4336 INFLUENCE OF GAMMA RAYS RADIATION OVER SOME ASSORTMENTS OF LEATHERS. Szymanski, W.; Zalewska, B. (Univ., Torun, Poland). Przegl. Skorzany; 22: No. 3, 52-5(1967). (In Polish).

Work was performed in order to estimate the influence of gamma radiation on various kinds of materials such as leathers, including vegetable-tanned leathers. Changes in properties of these leathers were estimated and their tensile strength and elongation resistance were tested. It was stated that chrome-tanned leathers were more receptive to radiation damages than those chrome retanned and far more receptive than vegetable-tanned leathers. (auth) (NSA of Poland)

4337 γ-RAY-INDUCED COPOLYMERIZATION OF CARBON MONOXIDE WITH CYCLIC HYDROCARBONS. Kagiya, Tsutomu (Kyoto Univ.), Kondo, Masatsune; Fukui, Kenichi; Yokota, Hisao. J. Polym. Sci., Part A-1(7): 2793-2803(Oct. 1969).

The γ-induced copolymerization of carbon monoxide with saturated or unsaturated cyclic hydrocarbons, such as cyclohexane, cyclohexene, 4-vinyl-1-cyclohexene, and cyclopentadiene was studied at 30°C. Resinous or powdery polymers were obtained in the copolymerization. The results of elementary analysis, infrared spectra, and NMR spectra showed that copolymers containing ketone and ring structures were produced. The copolymers were confirmed to be partially crystalline by the x-ray diffraction diagram. Further, the influence of the addition of ethylenimine on the copolymerization of carbon monoxide with cyclohexane or cyclohexene was examined. A powdery polymer formed in the copolymerization was concluded to be a terpolymer of carbon monoxide with cyclic hydrocarbon and ethylenimine. On the basis of the experimental results, a mechanism of the copolymerization is proposed. (auth)

4338 ELECTRON SPIN RESONANCE STUDIES ON TRAPPED ELECTRONS AND FREE RADICALS IN γ-IRRADIATED ISOBUTYL VINYL ETHER GLASSES. Tsuji, Kozo (Kyoto Univ.); Williams, Ffrancon. J. Phys. Chem., 73: 4017-22 (Nov. 1969).

ESR spectral studies showed that trapped electrons are produced by γ irradiation of pure isobutyl vinyl ether glasses (IBVE), and that the presence of IBVE contributes to increased thermal stability of trapped electrons in a 3-methylpentane (3-MP) glass. It was concluded that the diffusive motion of the electron governs the rate of thermal decay, and that the mobility is reduced by charge-dipole forces in polar (including olefinic) matrices. The results also shed some light on the photochemical and thermal reactions of the paramagnetic intermediates formed by the γ irradiation of pure IBVE. (P.C.H.)

4339 GRAFTING OF STYRENE-DIVINYLBENZENE MIXTURES ONTO PTFE FILMS. Vigo, F.; Canepa, G.; Munari, S. (Univ. of Genoa). J. Polym. Sci., Part A-1; 7: 3015-19(Oct 1969).

A study was made of the grafting reaction of polytetrafluoroethylene in the presence of styrene and divinylbenzene using the simultaneous irradiation technique both in controlled atmosphere and under vacuum. Data are presented in tables and graphs. (M.C.G.)

4340 MEAN AMPLITUDES OF VIBRATION IN SOME TRIATOMIC IONS. Sanyal, N. K.; Singh, H. S.; Pandey, A. N. (Univ. of Gorakhpur, India). J. Quant. Spectrosc. Radiative Transfer.; 9: 1647-50(Dec. 1969).

Mean square amplitudes and mean amplitudes of vibration for bonded and nonbonded atom pairs were evaluated at 0°, 298°, and 500°K, using Cyvin's method (Spectrochim. Acta 15: 828(1959)) for six linear symmetrical triatomic ions, ICl_2^-, IBr_2^-, II_2^-, NpO_2^{2+}, PuO_2^{2+}, AmO_2^{2+}. The mean amplitudes of vibration increased from lower to higher members of the halogen series, except at 0°K. For transuranic oxides the values slowly increased with increase in atomic number. (auth) (UK)

4341 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF METHACRYLIC ACID. I. CRYSTALLINE TRANSITION OF THE MONOMER. Sakai, Yoshiro; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Polymer. Sci., Part A-1; 7: 3143-50(Nov 1969).

The anomalous crystalline transition of methacrylic acid found by broad-line NMR measurements was studied in connection with the build-up and decay of trapped radicals. The build-up of radicals is smaller and the decay rate of the trapped radicals is faster in the low-temperature range (phase II), which gave the narrower maximum slope distance ΔH_{msl} of the NMR spectrum, than those in the higher temperature range (phase I), which gave the broader ΔH_{msl}. From these experiments it was concluded that in phase I the crystals have a more closely packed structure, resulting in a more rigid matrix for the trapped radicals than those in phase II. This interpretation is consistent with the temperature dependence of the ESR spectrum of the trapped propagating radicals previously reported. The existence of the crystalline transition was also confirmed by DSC measurements, and the effects of the crystallization conditions on the transition were investigated and were discussed with reference to the results of broad line NMR measurements. (auth)

4342 RADIATION-INDUCED POLYMERIZATION OF STYRENE IN THE PRESENCE OF n-DIBUTYL DISULFIDE. Miller, L. A.; Stannett, V. (Research Triangle Inst., Research Triangle Park, N. C.). J. Polymer. Sci., Part A-1; 7: 3159-76(Nov 1969).

The γ-induced polymerization of pure styrene and styrene—n-dibutyl disulfide mixtures was studied at a number of temperatures and dose rates. Up to 0.04 Mrad/hr the rates were proportional to the square root of the dose rate. By measuring the rates at a number of disulfide concentrations and at three different dose rates, the relative rates of radical formation were determined by kinetic analysis. Considerable energy transfer from the styrene to the disulfide was found. The relative contributions of energy transfer and radical formation were separated by using the kinetic scheme of Nikitina and Bagdasaryan. Values of 8.5 and 3.1 were found for the relative rates of radical production and energy transfer, respectively. This leads to a G (radical) value of 3.1 for n-dibutyl disulfide. With azobisisobutyronitrile as the initiator, the chain transfer constant to the disulfide was determined at 55°C. Finally, the sulfur content of a number of the polymers were determined, an average of two sulfur atoms per polymer chain was found. In general, the rate of polymerization was found to increase in the presence of dibutyl disulfide. (auth)

4343 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF METHACRYLIC ACID. II. IN-SOURCE POLYMERIZATION. Sakai, Yoshiro (Ehime Univ., Matsuyama, Japan). J. Polymer. Sci., Part A-1; 7: 3177-90(Nov 1969).

The in-source polymerization of methacrylic acid in the solid state with γ rays was studied. The conversion rates at various temperatures were obtained as well as the radical concentrations by the measurements of ESR spectrum. The rate of polymerization was found to be proportional to $I^{0.65}$ at 0°C. The results could be interpreted on the basis of the assumption that the rate of propagation is proportional to the concentration of the propagating radical, of the monomer, and of the polymer. The addition of water to the monomer seems to accelerate the polymerization reaction. The change of the line shape of the propagating radical during polymerization was interpreted in terms of the change of the matrix that surrounds the propagating radical. (auth)

4344 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF METHACRYLIC ACID. III. POST-POLYMERIZATION. Sakai, Yoshiro (Ehime Univ., Matsuyama, Japan). J. Polymer. Sci., Part A-1; 7: 3191-3201(Nov 1969).

The post-polymerization of methacrylic acid in the solid state was studied. The decay of the trapped radicals was also observed by ESR measurements. The decay of trapped radicals is a first-order reaction below 0°C but a second-order reaction at +10°C. The results of the post-polymerization were compared with the results of radical decay measurements. A kinetic scheme was proposed for the post-polymerization of methacrylic acid. The effect of conditions of monomer crystallization on the polymer yield was also investigated. Fine crystals gave a greater limiting conversion than large crystals. The addition of water to the monomer increased the polymer yield. The change in the ESR spectrum during post-polymerization was interpreted in terms of the change in the matrix which surrounds the propagating radicals. (auth)

Separation Processes

Refer also to abstracts 4202 and 4741.

4345 (BNWL-1073) WASTE SOLIDIFICATION PROGRAM. VOLUME I. PROCESS TECHNOLOGY: POT, SPRAY, AND PHOSPHATE GLASS SOLIDIFICATION PROCESSES. Schneider, K. J. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1969. Contract AT(45-1)-1830. 371p. Dep. CFSTI.

The majority of the pertinent waste solidification technology existing to date for the pot calcination, spray solidification, and phosphate glass solidification processes for converting highly radioactive liquid wastes to more refractory solids are presented. Pertinent technology regarding characterization of high-level liquid wastes, the solidified products, and the effluents from the three solidification processes is presented. (auth)

4346 (CEA-R-3754) PROCESSING ThC_2–UC_2 FUEL EXTRACTED FROM HIGH TEMPERATURE REACTORS HTGCR. Derrien, Claude; Lessart, Pierre; Pianezza, Eric; Verry, Christian; Villain, Gilles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1969. 127p. (In French). Dep. CFSTI (U. S. Sales Only).

The solubilization head-end (from crushing and grinding phase to nonincluded first purification phase) of pulverulent $(^{233}U/^{232}Th)C_2$ (200 to 500 microns diameter) contained in a graphite matrix extracted from a reactor with a $4 \times 10^{13} n \cdot cm^{-2} \cdot s^{-1}$ thermalized neutrons average flux and irradiation of 80,000 Mw(T). The burn-leach of reactor fuel and graphite matrix was chosen. The technology of the burner is original in the nuclear field and utilized ultrasound to intensify burning reaction and to minimize the weight of unburnables. The mixture of ThO_2, U_3O_8, and fission product oxides is dissolved by boiling 13 $\underline{M}$ HNO_3 + 0.05 $\underline{M}$ HF. Thorium recovery and reprocessing is considered. (auth)

4347 (CU-755-6) SEPARATION OF ISOTOPES. Annual Report, 1968. (Columbia Univ., New York. Dept. of Chemistry). Sept. 1, 1969. Contract AT(30-1)-755. 322p. Dep. CFSTI.

Six sections are included; one of which contains four parts. Separate abstracts were prepared for two sections and the four parts of another. The remaining sections contain only brief mention of developments made during the report period. (P.C.H.)

For abstracts of individual sections see: 4258–4260, and 4348–4350.

4348 (CU-755-6, Sect.2) CONCENTRATION OF ^{13}C BY CHEMICAL EXCHANGE REACTION BETWEEN AMINE CARBAMATE AND CARBON DIOXIDE IN A SOLVENT CARRIER SYSTEM. Ghate, M. R.; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). 22p.

The chemical exchange reaction between amine carbamates and CO_2 was investigated further to improve the system for the concentration of carbon-13. The effects of solvent, flow rate, catalysts, and concentration were studied for a number of amines. Of the solutions tested, di-n-butylamine (DNBA) in triethylamine (TEA) as solvent was the most favorable for further investigation of its use in the preparation of highly enriched carbon-13. The overall separations obtained as a function of the concentration of DNBA using a 2.5cm ID × 100 cm column ranged from $S_{13} = 2.05$ at 1$\underline{M}$ to $S_{13} = 1.69$ at 2.84$\underline{M}$. For 2$\underline{M}$ DNBA the maximum separation was $S_{13} = 1.94$. At this concentration of DNBA the overall separation as a function of flow rate ranged from $S_{13} = 1.94$ at 0.845 ml/cm^2-min to $S_{13} = 1.31$ at 2.9 ml/cm^2-min. Neither the rate of exchange nor the overall separations were improved by copper acetate of zinc acetylacetonate as catalysts. Increasing the column diameter twofold resulted in little or no loss in overall separations. (auth)

4349 (CU-755-6, Sect.7-A) ABSORPTION OF CARBON DIOXIDE IN NONAQUEOUS SOLUTIONS OF AMINES. Szempruch, Richard W. (Columbia Univ., New York. Dept. of Chemistry). 11p.

Studies were made on the volume of CO_2 absorbed per milliliter of amine solution as required for an investigation on the concentration of ^{13}C by the exchange of CO_2 with amine carbamates. Results obtained on the effects of solvents, such as methanol and triethylamine, on the absorption of CO_2 by di-n-butylamine are reported. Above about 2$\underline{M}$ di-n-butylamine in triethylamine, the moles of CO_2 absorbed per mole of amine dropped from 0.77 to 0.65 for 4.5$\underline{M}$ and 0.59 for pure amine. Methanol solutions of di-n-butylamine absorbed significantly more CO_2 per mole of amine. Measurements on the solubility of CO_2 in the solvents showed that CO_2 was significantly more soluble in methanol than in triethylamine. Data are tabulated. (P.C.H.)

4350 (CU-755-6, Sect. 7-D) SOLUBILITY OF METHYLACETYLENE IN VARIOUS TUBINGS. Todosow, Michael (Columbia Univ., New York. Dept. of Chemistry). 8p.

In experiments involving the use of methyl acetylene in systems containing large amounts of tygon tubing for the concentration of deuterium, a time dependent change in the pressure within the system was observed. Studies were made to determine whether this observed pressure change was due to methylacetylene dissolving within the tygon and or diffusing through it. Several types of tubing, such as tygon, silicon, rubber, butyl rubber, polyethylene, teflon, nylon, and glass, were tested. The results indicated that a rather severe pressure drop occurred in most of the tubing in a relatively short period of time. This was attributed to methylacetylene dissolving within the walls and/or diffusing out. In the case of tygon, it was found that the pressure drop was caused primarily by methylacetylene dissolving within the walls. Data are tabulated. (P.C.H.)

4351 (DOCKET-50201-8) [WEST VALLEY REPROCESSING PLANT]. Provisional Operating License No. CSF-1. [Preliminary Safety Analysis Report], Amendment 7. (Nuclear Fuel Services, Inc., West Valley, N. Y. New York State Atomic and Space Development Authority, New York). 18 Mar 1969. 12p. Dep. CFSTI.

A request for renewal of the provisional operating license is presented. (M.C.G.)

4352 (DOCKET-50268-3) MIDWEST FUEL RECOVERY PLANT. Design and Analysis, Amendment 1 to Suppl. 1. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). 22 Oct 1969. 20p. Dep. CFSTI.

Additional information on earthquake and wind analysis for the Midwest Fuel Recovery plant is presented. (M.C.G.)

4353 (ORNL-tr-2255) VAPOR–WATER PARTITION COEFFICIENT OF IODINE AND ORGANIC IODIDES. Nishizawa, Yukinori; Kigoshi, Yasutane; Oshima, Shigeo; Ozawa, Yasutaka; Maekawa, Tatsuo. Translated by Hisashi Kubota (Oak Ridge National Lab., Tenn.), from Nippon Genshiryoku Gakkaishi; 11: 205-10(1969). 13p. Dep. CFSTI.

In developing a safety system for light water power reactors, determinations were made of the vapor-water partition of iodine and its compounds to enable a better theoretical treatment of the spray removal effect of iodine by container sprays. Partition coefficients were determined for iodine, iodomethane, and iodobenzene. (M.C.G.)

4354 A METHOD AND APPARATUS FOR DECANNING NUCLEAR SLUGS BY THERMALLY MELTING THE CAN. Fondanaiche, Jean-Claude; Gauthron, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,165,869. Oct. 1, 1969. Priority date Sept. 20, 1967, France.

A method and apparatus are described for decanning nuclear slugs by thermally melting the can in an inert atmosphere at a temperature below the temperature of the substance forming the slug. The can may be melted by merely heating the chamber containing the slug, by immersing the slug in a bath of molten metal, or by the slug remaining fixed in relation to the chamber and being immersed as the bath level rises. (B.L.M.)

4355 SOLVENT EXTRACTION OF NON-FERROUS METALS. Flett, D. S. (Warren Spring Lab., Stevenage, Eng.). Rep. Progr. Appl. Chem.; 53: 696-703(1968).

A review is given of industrial processes, together with recent research. The metals covered include rare earths, Nb, Ta, V, W, B, Be, Zr, and Hf. 51 references. (UK)

4356 PROCESS FOR DISINTEGRATING GRAPHITE BODIES. Knotik, Karl; Leichter, Peter Hans; Wagner, Harald (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,165,453. Oct. 1, 1969. Priority date Apr. 12, 1966, Austria.

A process for disintegrating graphite bodies is described for application to the separation of nuclear fuel particles from graphite bodies in which the fuels are embedded. The process comprises immersing the graphite bodies in a liquid oxidizing medium containing peroxymonosulfuric acid, peroxydisulfuric acid, or an ammonium or alkali metal salt of peroxydisulfuric acid or in a mixture of H_2O_2 and sulfuric acid. The graphite is obtained in the form of powder while the fuel particles are not attacked by the oxidizing medium forming a slurry in which the graphite powder is separated from the fuel particles by gravity. (B.L.M.)

4357 ISOTOPIC COMPOSITION OF HAILSTONES. **Bailey, I. H. (Western Australia Inst. of Tech., Bentley); Hulston, J. R.; Macklin, W. C.; Stewart, J. R. J. Atmos. Sci., 26: 689-94(July 1969).**

A theoretical explanation is given for the change in hydrogen isotopic ratio during freezing time for a hailstone, and experimental confirmation of this is presented. Isotopic fractionation can occur during the freezing of supercooled droplets due to evaporation from the liquid during the freezing process with consequent enrichment of the deuterium and ^{18}O content of the accreted ice. The enrichment is greatest when the temperature of the hailstone is near 0°C. Calculations, based on the Rayleigh distillation formula and allowing for diffusivity effects, indicate that the maximum increase is about 6‰ for deuterium and 1.5‰ for ^{18}O. Analysis of samples of accreted ice formed in an icing tunnel confirmed these predictions, and showed that the effect is sufficiently large to affect the interpretation of isotopic analyses of hailstones. Analyses of hailstones gave variations in D/H and $^{18}O/^{16}O$ ratios of about 20‰ and 2‰ respectively. An analysis of the growth history of a hailstone may be feasible, provided allowance is made for deuterium and ^{18}O enrichment due to evaporation during the freezing of the droplets. If the growth is close to the wet limit during the entire history of the stone, a constant correction only need be added. However, if the growth of the stones varies between the wet and dry regimes then the analysis becomes more complicated. (BBB)

4358 PRESERVATION OF RADIOACTIVE SOLUTIONS: EFFECT OF SILICONE TREATMENT OF BOTTLES. **Bignardi, G. (Univ., Genoa). Farmaco (Pavia) Ed. Prat., 22: 800-10 (Dec. 1967). (In French).**

Ways were sought for improving the storage conditions of radioisotope solutions, and especially for reducing adsorption of the isotope on the glass of the containers. The study was carried out with 15-ml penicillin-type ampoules made of neutral, Verlica-Momignies glass. Solutions at various pH values of the following isotopes were studied: ^{22}Na, ^{32}P, ^{59}Fe, ^{86}Rb, and ^{131}I. Three different silicone preparations were used to treat the glass and thereby reduce adsorption: SI 35 B emulsion, SI 200/350 csk fluid, and SI 1107 resin. In general, it was found that solutions of ~ pH 10 showed less isotope change than neutral (pH 7) solutions, but no consistent relation between loss of activity of the solution and pH was evident. Silicones of the 3 types were equally effective with cationic radioisotopes. Variations of cation isotope activity were between 98 and 102% of initial activity, for up to 1-mo storage time. With anions the loss was greater, e.g., 6.5% for ^{131}I at pH 9.4 and 10% for ^{32}P at pH 3.5. The ^{59}Fe solutions were most stable. (BBB)

4359 A REVIEW OF THE LITERATURE OF 1968 ON WASTEWATER AND WATER POLLUTION CONTROL: INDUSTRIAL WASTE, RADIOACTIVE. **Straub, C. P. J. Water Pollut. Contr. Fed., 41: 1223-51(June 1969).**

The following topics relating to radioactive industrial waste disposal were reviewed (with 167 references): U recovery, waste water treatment by precipitation of radionuclides, solvent extraction, ion exchange, adsorption, uptake on natural materials, electrodialysis, and fixation; ground disposal; disposal in the hydrosphere (oceans, rivers); uptake on sediments; monitoring; and analysis. In the United States increased emphasis is placed on concentrating, solidifying, and containing wastes. Only a nonhazardous, economically irreducible minimum of radioactive material is to be discharged to the environment. Waste management practice at nuclear power plants operates within the limits authorized for release of radioactive wastes to the environment at costs estimated to range between 2 and 10% of their total operating costs. The average activity in liquid wastes varies from 0.01 to 11.1 Ci, exclusive of ^{3}H. Tritium levels range from 5 to 1300 Ci annually. Use of high-pressure washing and rewashing for leaching U from mined-out areas is referred to. Removal of specific radionuclides by various treatments of waste water is outlined. The presence of detergents affects the treatment of wastes by precipitation; the effect is increased at increased detergent concentrations and generally increases with decreased pH. How ^{90}Sr is extracted from various radioactive waste solutions at the Hanford B plant is explained. A study to determine if low-cost nuclear energy, heat, radiation, or electricity could be used to reduce the cost of waste water treatment is reviewed. (BBB)

4360 METHOD FOR SEPARATING URANIUM AND PROTACTINIUM FROM SPENT MOLTEN FLUORIDE SALT MIXTURES CONTAINING RARE EARTH FISSION PRODUCTS. **Shaffer, J. H.; Moulton, D. M.; Grimes, W. R. (to United States Atomic Energy Commission). U. S. Patent 3,473,897. Oct. 21, 1969.**

A method for reprocessing spent molten metallic fluoride salt mixtures containing U is described in which U and bred-in Pa values are selectively extracted from the salt phase containing rare earth fission products into an immiscible metal solution by controlling the reduction potential between the metal and salt phases. Uranium values, which are extracted first, are oxidized and transferred from the metal solution into a barren salt mixture for ultimate recycle to the reactor prior to extracting the contaminants. The Pa values are then extracted into the metal solution, oxidized, and transferred from the metal solution into a molten salt outside the reactor environment to await decay of the ^{233}Pa to ^{233}U. (AEC)

4361 LIQUID-LIQUID REMOVAL OF PROTACTINIUM FROM SPENT MOLTEN SALT MIXTURES CONTAINING URANIUM TETRAFLUORIDE. **McNeese, L. E.; Watson, J. S.; Whatley, M. E. (to United States Atomic Energy Commission). U. S. Patent 3,472,633. Oct. 14, 1969.**

A continuous liquid-liquid countercurrent extraction method for reprocessing spent molten fluoride salt reactor fluids containing UF_4 is described by which the U values are reductively extracted into an immiscible molten metal solution containing a metal reductant selected from the group consisting of Li and Th while the Pa values are held up and concentrated in the extractor by a continuous reflux. (AEC)

4362 CRITICALITY AND CHEMICAL PLANT. PART 1. REVIEW OF BASIC CONCEPTS AND THEIR APPLICATIONS. **Chalmers, J. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc.; 8: 325-32(Oct 1969).**

In the fabrication and reprocessing of nuclear reactor fuels, fissile material is handled under widely varying conditions and in addition to conventional chemical plant hazards it is necessary to guard against accidental criticality. Factors which affect the criticality of systems containing fissile material are reviewed and the sources of criticality data are indicated. An outline is also given of nuclear safety philosophy and the application of basic data to chemical plants. (auth) (UK)

4363 SEPARATION OF LITHIUM ISOTOPES. **Smit, Wilhelm Matthijs; Arkenbout, Gerardus Johannes (to Nederlandse Centrale Organisatie voor Toegepast-natuurwetenschappelijk Onderzoek). U. S. Patent 3,463,606. Filed June 3, 1965.**

A process is described for enriching Li isotopes with an exchange column having a return circuit at the upper end and a return circuit at the lower end and in which Li amalgam is contacted with a Li salt dissolved [illegible] an organic amine solvent. (Offic. Gaz.)

4364 PROCESS OF ISOTOPIC ENRICHMENT BY BITHERMAL EXCHANGE NH_3-H_2. **Courvoisier, Pierre; Lambert, Irma (to Commissariat a l'Energie Atomique). U. S. Patent 3,464,789. Priority date June 30, 1965, France.**

In an isotopic enrichment process by bithermal exchange between NH_3 and H_2, the speed of exchange between gaseous H_2 and liquid NH_3 may be advantageously increased when an ether soluble in the solution is added to the ammonical solution of an alkali amide. The ether is preferably an acyclic or cyclic ether, and the choice of the ether is solely limited by the solubility of the ether in the mixture. (Offic. Gaz.)

4365 TRIISOOCTYLAMINE EXTRACTION OF Mo(VI) IN HYDROCHLORIC MEDIUM. **Vieux, Aliette S.; Amand, Johan (Univ. Lovanium, Kinshasa, Congo). Bull. Soc. Chim. Fr.; No. 9, 3366-7(Sep 1969). (In French).**

The molybdenum distribution between the organic aqueous phases depends on the hydrochloric acid concentration of the aqueous phase during molybdenum (VI) extraction by triisooctylamine solution in benzene and xylene. The formula of the highly acid compound extracted was determined. The dissociation constant was determined; it depends on the solvent. (auth)

4366 URANYL ACETATE EXTRACTION BY TRI-ISOOCTYLAMINE SOLUTION IN VARIOUS ORGANIC SOLVENTS. **Vieux, Aliette S. (Univ. Lovanium, Kinshasa, Congo). Bull. Soc. Chim. Fr.; No. 9, 3364-6(Sep. 1969). (In French).**

Equilibrium constants of triisooctylamine acetate were determined in benzene and xylene. The influence of acidity on the extraction yields, the formula of the organic complex extract, and the dissociation constant were studied during the amine extraction of uranyl acetate in acetic acid medium. (auth)

4367 THE INFLUENCE OF THE AUXILIARY WATER AND OF NITRIC ACID FLOW-RATE ABOUT ^{15}N SEPARATION IN NITROX SYSTEM. **Axente, D.; Fodor, T. (Inst. of Atomic Physics, Cluj). Isotopenpraxis; 5: 267-9(Jul 1969).**

The experimental results obtained for ^{15}N separation by the Spindel-Taylor method, in a laboratory exchange column are presented. The influence of the auxiliary water flow and of the nitric acid flow rate (0.6 – 2.6 ml/cm^2 min) on the ^{15}N separation was studied. All the experimental points were obtained in unsteady state, thus giving information about the rate of the steady-state achievement. (auth)

4368 A SYSTEM FOR THE ENRICHMENT OF LOW-LEVEL TRITIUM IN LARGE VOLUME HYDROGEN SAMPLES BY GAS CHROMATOGRAPHY. Perschke, H.; Crespi, M. B. A.; Cook, G. B. (International Atomic Energy Agency, Seibersdorf, Austria). Int. J. Appl. Radiat. Isotop.; 20: 813-19(Dec 1969).

A chromatographic system is described in which amounts of about one mole of hydrogen containing tritium at very low levels can be enriched 40 times with 100% tritium recovery. The system is based on previous work by the authors with smaller samples and was tried successfully at 10^{-13} mole per cent tritium concentrations. It appears useful to concentrate samples for measuring purposes when these are available only in up to one mole quantities. (auth) (UK)

4369 EXTRACTION OF CURIUM AND EUROPIUM WITH 1-PHENYL-3-METHYL-4-BENZOYLPYRAZOLONE-5 SOLUTIONS IN VARIOUS SOLVENTS AND IN THE PRESENCE OF DONOR-ACTIVE ADDITIONS. Chmutova, M. K.; Kochetkova, N. E. (Ural Polytechnical Inst., Sverdlovsk, USSR). Zh. Anal. Khim.; 24: 1757-9(Nov 1969). (In Russian).

Curium and europium can be quantitatively extracted with 1-phenyl-3-methyl-4-benzoylpyrazolone-5 (PMBP) solutions in isoamyl, n-butyl and benzyl alcohols at pH 1 to 2; they can be also extracted with PMBP solutions in cyclohexane in the presence of tributyl phosphate and trioctylphosphine oxide as donor-active additions from 0.1 to 0.3 $\underline{N}$ solutions of HNO$_3$. (auth)

4370 SYNERGISTIC EXTRACTION OF METALS. Htaik, Than (Arts and Science Univ., Rangoon). Union Burma J. Sci. Technol.; 2: No. 1, 1-8(Apr 1969).

The fundamental theory of synergistic extraction is explained. The liquid – liquid equilibrium data at 25°C are presented to explain this theory for the system uranyl sulfate – water, naphthenic acid plus tri-n-butylphosphate – kerosene. (auth)

4371 PURIFICATION OF PLUTONIUM. Watanabe, Kenju (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 11: 687-90(1969). (In Japanese).

A description is given of the procedure developed for the purification of Pu. The anion and cation exchange techniques using nitric acid and hydrochloric acid systems were applied to separate impurities such as Fe, Al, and Am from both micro and macro quantities of Pu. (auth)

4372 PROCESS FOR SEPARATING YTTRIUM FROM THE LANTHANIDE ELEMENTS. Gump, J. R. (to Sylvania Electric Products Inc.). U. S. Patent 3,482,932. 9 Dec 1969. Filed 5 Feb 1968.

Yttrium and the heavier rare earth elements of the lanthanide series are separated from the lighter rare earth elements by means of a solvent extraction process using a mixture of monoesters and diesters of tridecyl orthophosphoric acid as the active organic reagent and a nitrate system for the aqueous phase. The yttrium and heavy rare earth elements recovered from the organic phase of the solvent extraction process are then passed through an ion exchange system where yttrium is separated from the heavy rare earths. (Offic. Gaz.)

4373 SYNTHETIC INORGANIC ION-EXCHANGE MATERIALS. XIII. THE MUTUAL SEPARATION OF ALKALI METALS WITH THREE DIFFERENT ANTIMONIC ACIDS. Abe, Mitsuo (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 42: 2683-5(Sept. 1969).

Studies were made on the efficiency of three different antimonic acids, amorphous (S$_A$), glassy (S$_G$), and crystalline (S$_C$), for the chromatographic separation of alkali metal ions. The concentration of alkali metals was determined flame-photometrically. The results indicated the presence of antimonic acid of two types, with a different selectivity for alkali metal ions. The S$_G$ and S$_C$ were favorable for column work because of their lower solubilities and their suitable granular forms. The S$_C$ was especially stable against almost all reagents, including concentrated acid and alkaline solutions and oxidizing agents. The S$_A$ was unsuitable, since it was relatively soluble in water and was gradually transformed into crystalline antimonic acid in a relatively concentrated acid solution. (P.C.H.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstract 4386.

4374 (CEA-R-3762(2)) STUDY METHODS FOR BORINGS CARRIED OUT NEAR THE UNDERGROUND NUCLEAR EXPERIMENTS IN THE SAHARA. PART 2. TECHNIQUES FOR STUDYING THE WALLS OF THE BORE-HOLES. Faure, Jean (Commissariat a l'Energie Atomique, Bruyers-le-Chatel (France). Centre d'Etudes). Oct 1969. 26p. (In French). Dep. CFSTI (U. S. Sales Only).

Measurements by drilling were carried out for the underground nuclear explosions on the Sahara test site for observation of the rock by television and permeability measurements. A description is given of the technique used along with design of equipment and its operation. Problems arising from the interpretation of the results are considered. The conclusion stresses the importance of the results of this work from the point of view of possible industrial applications. (auth)

4375 (UCLA-12-757) SPURIOUS THERMOLUMINESCENCE OF SOILS. Nishita, H.; Hamilton, M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [nd]. Contract AT-04-1-GEN-12. 21p. Dep. CFSTI.

Spurious thermoluminescence of six soils differing widely in physical and chemical characteristics was examined. As observed by previous investigators working with other materials, the spurious glow of soils also appeared to be dependent on the oxygen adsorbed on the surface of the luminescent particles. The amount of natural spurious thermoluminescence depended on the kind of soil. Spurious (surface) glow and volume glow were increased considerably by exposing the soils to ^{60}Co photons. The increase of the surface glow relative to that of the volume glow on irradiation depended also on the soil. One soil (Aiken clay loam) examined showed that it is possible to obtain the increase of surface glow on irradiation without the formation of detectable amounts of volume glow. Except for one soil (soil No. 4FF), the volume glow of the soils exposed to ^{60}Co photons occurred predominantly in the low temperature range (<250°C), while the surface glow occurred predominantly in the high temperature range (>250°C). The large amount of volume glow induced in soil No. 4FF by irradiation appeared to be due to its high lime content. (auth)

4376 DISTRIBUTION OF NEUTRONS FROM A ^{252}Cf SOURCE IN SOIL AT DEPTH AND JUST BELOW THE AIR-GROUND INTERFACE. Senftle, F. E.; Philbin, P. W.; Sarigianis, P. (Dept. of Interior, Washington, D. C.). Nucl. Appl. Technol.; 7: 576-83(Dec 1969).

The slow-neutron flux as a function of distance from a 90 μg ^{252}Cf neutron source buried several feet below the surface of the ground was measured with BF_3 detectors in damp sand and clay strata. From 1 to 7 ft from the source, the expected decrease in flux was observed. However, when similar measurements were made in shallow holes near the air-soil interface, the decrease with distance was less than exponential and a peak was noted at a distance of 8 ft from the source. A qualitative explanation of the peak is given indicating that the density of thermal neutrons in the high-density thermal strata located several inches below the surface is a function of the incident neutron energy and that the optimum incident energy is ~2 MeV. For this reason ^{252}Cf is a good neutron source for the purpose of in situ capture gamma analysis of soil constituents when used for mineral exploration purposes. (auth)

4377 URANIUM AND THORIUM IN TEKTITES. Morgan, J. W. (Univ. of Kentucky, Lexington). Earth Planet. Sci. Lett.; 7: 53-63(Oct 1969).

Neutron activation analysis for uranium and thorium is reported for two australites, a javaite, a bediasite, and a moldavite. A critical survey is made of published uranium and thorium abundances in tektites, and superior analyses selected. Uranium and thorium abundances in the tektite groups are compared with terrestrial sedimentary and acid igneous rocks. Granophyres matched tektites most closely in the abundance of these two elements, but could not be considered probable parent material for a terrestrial tektite origin because of their limited distribution. An extraterrestrial origin was also considered and a relationship in uranium and thorium abundance is observed between some achondrites and the tektites. (auth)

4378 ANNEALING EFFECTS IN MUSCOVITE AND THEIR INFLUENCE ON DATING BY FISSION TRACK METHOD. Mehta, P. P.; Rama (Tata Inst. of Fundamental Research, Bombay). Earth Planet. Sci. Lett.; 7: 82-6(Oct 1969).

Effects of geological annealing of fission tracks in muscovite are compared with those produced in the laboratory at high temperatures, and their influence on dating by fission track method examined. (auth)

4379 NATURAL AND FALLOUT RADIOACTIVITY IN THE SOIL. de Bortoli, M. C.; Gaglione, P. (Joint Research Centre Ispra, Italy). Health Phys.; 17: 701-10(1969).

The long-lived radionuclides (^{90}Sr,^{137}Cs, and ^{239}Pu) from weapon fallout were measured in soil samples collected in the surroundings of the Euratom Ispra Establishment (Northern Italy). The vertical profile of the contamination and the distribution of ^{137}Cs in soil particles of different size were studied. In addition, also the concentration of natural radionuclides was determined and the calculated air dose-rate has been compared with that measured by means of a portable ionization chamber. (auth) (UK)

4380 LEAD ISOTOPE STUDY OF ORES AND ADJACENT ROCKS. Reynolds, Peter Herbert. Vancouver, B. C.; Univ. of British Columbia (1968).

Thesis.

The isotopic relationships between lead in orebodies and lead in adjacent igneous rocks were investigated. Past studies of rocks and ores have been largely uncorrelated, and, in addition, much of the published data is unreliable because of large experimental uncertainties and inadequate interlaboratory calibrations. These data have, however, suggested that most rock-leads originated in a system with a distinctly lower U/Pb ratio than the one associated with certain ore-leads. Both rock-leads and ore-leads were analyzed from Balmat, N. Y. and from Nelson, B. C. Rock-leads from Broken Hill, Australia and from West-Central New Mexico were also studied. The isotopic abundances of ore-leads from these latter two areas have already been determined in this laboratory. Identical experimental techniques were used throughout for both rocks and ores, and a precision of better than 0.10 percent (one standard deviation) in the measurement of isotope ratios with respect to lead-204 was achieved. Rock-leads from Balmat and from the Nelson batholith, ore-leads from deposits associated with this batholith, and ore-leads from New Mexico were apparently derived from a primary system characterized by a present-day value of the ^{238}U/^{204}Pb ratio (the μ-value) equal to 8.7 to 8.8_5. Ore-lead from one of the stratiform deposits at Balmat was apparently derived from a primary system with a μ-value of 9.0. This value agrees with the one obtained for stratiform deposits selected in accordance with geological criteria. It is also consistent with the interpretation of the isotopic abundances of lead from the Sullivan mine and from deposits located in the Kootenay arc north and south of the Nelson batholith. In addition, both rock-leads and ore-leads from Broken Hill appear to reflect the existence of this higher μ system. The present study has therefore provided, for the first time, definitive evidence relative to the existence of two distinct distributions of primary μ-values. Several geophysical models are discussed in an attempt to reconcile this difference, and explain in general terms the evolution of lead isotope ratios in the earth. Also, for the first time, analyses of Nelson rocks and ores have provided clear evidence of a genetic relationship between ore deposits and granitic rocks. At the same time, lead isotope abundance patterns in plutonic rocks of batholithic dimensions were investigated. (Diss. Abstr. Int., B)

4381 OPTIMISATION OF LIQUID SCINTILLATION RADIOCARBON AGE DETERMINATIONS AND REPORTING OF AGES. Polach, H. A. (Australian National Univ., Canberra). At. Energy Aust., 12: 21-8(July 1969).

The activities of the Radiocarbon Dating Laboratory, Department of Geophysics and Geochemistry, Australian National University, are described. Both methane (CH_4) gas proportional and benzene (C_6H_6) liquid scintillation counting techniques are used. Interference with counting operations and low-background determination from a near-by Van de Graaff tandem accelerator caused suspension of gas-counting operations pending construction of a shielded counting room. Liquid scintillation determination was continued, using a 5 ml capacity, low background, low evaporation loss, counting vial designed for use in automatic liquid scintillation spectrometers. Observed average interference of approximately 0.6 cpm over a period not exceeding 12 to 24 hours in a particular week was significantly reduced by accumulating fifty 200 minute counts for a number of vials, which include background samples, over a period of one week, instead of single-vial continuous 1000 minute counts. Checks were performed on the over-all stability of the liquid scintillation spectrometer to ensure that prolonged counting for several weeks on a group of vials would not be affected by discriminator shift due to low-voltage vibrations and photomultiplier instability. The system of cycling was achieved by initially establishing the background count rate of each sample vial and relating it to the sealed background vials and monitoring the ^{14}C (800 cpm) standard. The cycling method provides quasi-simultaneous background and modern count rate checks, improves instability and long-term reproducibility and almost trebles output. Data processing is handled by two major and four minor computer programs. The calculation methods practiced are described. (Australia)

Meteorology

Refer also to abstracts 4418, and 4588–4590.

4382 (FOA-4-4390) RADIOACTIVITY FROM NUCLEAR WEAPONS TESTS IN AIR AND PRECIPITATION IN SWEDEN 1967 AND 1968. Bernstroem, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). June 1969. 15p. Dep. CFSTI (U. S. Sales Only).

Analyses of the radioactivity of ground level air and precipitation are reported for 1967 and 1968. New devices for sampling ground level air with greater capacity were installed. The mean cesium-137 concentration of 1967 decreased with a factor 3 compared to the preceding year following the same pattern as previous years since the cessation of the atmospheric nuclear weapon testing in late 1962. Probably due to the Chinese thermonuclear test 1967, the cesium-137 concentration increased during 1968 to 1.5 times that of 1967. The mean total accumulated activity on the ground of cesium-137 was at the end of 1968 equal that at the end of 1966 (55 mCi/km^2). The short-lived activities of zirconium-niobium-95, cerium-144 and ruthenium-106 are also reported. (auth) (Sweden)

4383 (NP-18053) A REPORT ON THE METEOROLOGICAL ASPECTS OF RADIOACTIVE FALLOUT OVER AUSTRALIA FROM THE 1966 NUCLEAR TESTS AT MURUROA ATOLL (INCLUDING A NOTE ON FALLOUT FOLLOWING THE 1967 NUCLEAR TESTS). Meteorological Study No. 17. Trefry, G.; Callus, F. (Bureau of Meteorology, Melbourne (Australia)). Sept. 1969. 103p. Dep. CFSTI (U. S. Sales Only).

Some of the meteorological factors associated with radioactive fallout over Australia following nuclear tests held in the South Pacific Ocean area in 1966 are discussed. Wind patterns suggested that most of the debris which reached Australia was transported in a west to east direction by strong westerly winds in the upper levels. Some debris moved into lower latitudes from the test site at lat 22°S, and followed an east to west trajectory. There were indications that the debris clouds showed rapid latitudinal dispersion in the first few days, followed by only limited additional dispersion over longer periods. This was attributed to dispersion in the traveling waves in the westerly winds. Within the Australian region fallout was normal in the sense that all the more active samples were associated with rain, and there was a strong correlation between sample activity and the depth of atmosphere scoured by rain and turbulence. In a climatological sense the 1966 fallout distribution over Australia was probably abnormal, since the maximum deposition recorded in the center of the continent was due to unseasonal rains in a region which normally shows great atmospheric stability, and experiences infrequent rain, in the winter and early spring months. On a synoptic scale, fallout tended to reach a maximum in warm and unstable northwest winds ahead of upper level pressure troughs, and a minimum in the colder southwest winds behind each weather change. In general, the low level of fallout over Australia during 1966 was consistent with debris dispersion and decay over substantial travel times and distances, and with relatively infrequent scouring of the higher tropospheric layers by deep cloud and turbulence. (auth) (Australia)

4384 RATES OF PRODUCTION OF ^{24}Na AND ^{28}Mg IN THE ATMOSPHERE BY COSMIC RADIATION. Bhandari, N.; Fruchter, J.; Evans, J. (Univ. of California, San Diego). Earth Planet. Sci. Lett.; 7: 89-92(Oct 1969).

The rates of production of ^{24}Na and ^{28}Mg in argon exposed to cosmic rays at geomagnetic latitude 41°N and 750 g cm^{-2} atmospheric depth were measured to be $(2.9 \pm 0.3) \times 10^{-2}$ and $(1.2 \pm 0.6) \times 10^{-2}$ atoms per kg argon per min, respectively. Using the data available for altitude and latitude dependence for cosmic-ray production of isotopes, their average production rate in the atmosphere is calculated. (auth)

4385 INTERHEMISPHERIC TRANSFER OF RADIOACTIVE POLLUTION FROM NUCLEAR EXPLOSIONS. Peirson, D. H. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Trans. Roy. Soc. London, Ser. A; 265: 295-300(13 Nov 1969).

By using a simple model of the atmosphere, having two compartments, it is possible to derive expressions for the fission product reservoirs of the northern and southern hemispheres as functions of the gross rate of exchange between hemispheres, and the fallout rate. When observed values (1963 to 1966) for the fission products are inserted into the theoretical expressions it is possible to extract approximate estimates of the rate of interhemispheric transfer, and the ratio of northern and southern reservoirs at any time. (auth)

4386 ^{210}Pb PRODUCTION BY NUCLEAR DEVICES: 1946–1958. Beasley, T. M. (Univ. of Washington, Seattle). Nature (London); 224: 573(Nov. 8, 1969).

The possible production of ^{210}Pb during weapons testing by the reaction $^{208}Pb(2n,\gamma)^{210}Pb$ is discussed. Unusually high ratios of ^{210}Pb in tropospheric air in 1962 and 1963 and in lichens and deer antlers in 1958 to 59 and 1962 to 63 were reported; on the other hand, no corresponding increase in air or glaciers and the stratosphere in 1966 was reported by other workers. Resolution of this difference in findings was considered important since it was postulated that nuclear devices used in excavating a canal in Central America might produce ^{210}Pb in amounts comparable with ^{90}Sr–^{90}Y. If ^{210}Pb is produced in significant amounts during nuclear explosions it should be present at former test sites at Bikini and Eniwetok Atolls, and the presence of ^{207}Bi at these sites suggests that stable lead was present in shielding or other structures adjacent to the nuclear devices. Determinations of the ^{210}Pb content of soil and sediment samples from areas of high radioactivity in the Pacific Proving Ground and, for comparison, from areas of the Pacific with negligible fallout are reported; three of the samples contained ^{207}Bi. The results show concentrations of ^{210}Pb that do not exceed those expected to occur naturally, and if ^{210}Pb had been produced in significant amounts during the testing programme the concentrations in crater sediments would have been much greater than found. (UK)

4387 TUNGSTEN RADIOISOTOPES IN THE ATMOSPHERE NEAR PISA, ITALY. de Franceschi, L.; Gentili, A.; Gremigni, G.; Guidi, P. (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Nature (London); 224: 571-3(Nov. 8, 1969).

In the course of routine surveys of environmental radioactivity high values of delayed beta activity on paper filters were reported on Dec. 18 to 20th 1968. Accompanying alpha activity was not found, but the gamma spectrum had an unusual shape. The bulk of the counts was not due to fission products or other normal fallout components, but was primarily concentrated in the low energy region; the peak energy was 58 ± 1 keV, and a gamma activity decay measurement gave a half-life of 140 ± 10 days. On the other hand the beta activity decay led to a half-life of 74 ± 5 days. This led to a consideration of ^{181}W and ^{185}W as the nuclides responsible. The ^{181}W has an orbital electron capture decay with $T_{1/2}$ of 140 to 145 days, and its daughter ^{181}Ta emits 58 keV x-rays. The ^{185}W shows pure beta decay with $T_{1/2}$ 70 to 76 days. The tungsten was chemically separated as $WO_3.H_2O$; more than 90% of the activity was recovered and the spectrum appeared indistinguishable from before separation. Quantitative measurements were also made of ^{181}W and ^{185}W and a number of other single activities; in daily filters all fallout nuclides except W were insignificant in amount. Neither W isotope is a fission product although both were previously found in fallout. The 1958 Hardtack test programme weapons included W, so that by activation ^{181}W and ^{185}W could be produced for use as tracers to study the worldwide distribution of fallout. Large quantities of W were also produced in 1962 from the underground test in the Nevada Desert. The present results appear to indicate that W was present in more recent nuclear weapons, either for special purposes or in device components. (UK)

4388 TOTAL EXTERNAL AND INTERNAL IRRADIATION OF REINDEER-BREEDING LAPPS OVER THE 20-YEAR PERIOD 1951–1970. Gustafsson, Monica; Liden, Kurt (Lund Univ., Sweden). Nord. Med., 81: 429-33(1969). (In Swedish).

The transport of fallout from nuclear tests, especially ^{137}Cs, in the food chain lichen-reindeer-man has been studied since 1961. For a reasonable estimate of the importance of the artificial irradiation, knowledge of the natural background is required. An environmental γ-radiation survey in part of the reindeer-breeding district of Sweden in 1967 provided this background. The radioecological investigations of the total irradiation of Swedish reindeer breeders between 1951 and 1970 supplemented observations in other arctic countries. Comparison with other population groups was made. From the present investigation it was concluded that the additional irradiation of people consuming reindeer meat does not exceed the limit for the variation in the natural background irradiation of other population groups in the Northern countries. (auth)

Mineralogy and Exploration

Refer also to abstract 4376.

4389 (CONF-670851-1) URANIUM RESERVES AND PROGRESS IN EXPLORATION AND DEVELOPMENT. Geological Survey Circular 547. Butler, Arthur P. Jr. (Geological Survey, Washington, D. C.). 1967. 8p. Geological Survey, Washington, D. C. Free.

From Coal Industry Executive Conference, Washington, D. C.

A review of estimated demand for U in relation to the known and potential resource base is presented. It is noted that the U needed to fuel reactors ordered in the future will have to come largely from deposits yet to be discovered. The possibilities are good that with intensive exploration the search for U will be successful. (J.R.D.)

4390 RECENT DEVELOPMENTS IN URANIUM EXPLORATION. Griffith, J. W. (Rio Algom Mines Ltd., Toronto); Hart, R. C. West. Miner, 41: 44-55(July 1968).

The present status of the uranium mining industry especially in Canada and United States is reviewed with special emphasis on some geological aspects of uranium and development of exploration techniques. Considerable attention is given to the economics of potential supplies including grade and probable demand in the 1970's. No shortage is contemplated for prices in the range of 8 to $10 per pound. Recent discoveries and areas of interest are surveyed. Large low grade deposits which normally can only be mined at very large tonnage throughputs will be required to fulfill the probable deficiency in recent output. The more efficient use of reserves will help smooth out fluctuations in price and supply. However, assurance of a long term stable price with adequate protection from rising labor and material costs will be required to encourage the major capital investment needed for new and larger ore treatment plants. (F.S.A.)

4391 URANIUM AND THE BEAVERLODGE DISTRICT. Trigg, C. M. (Trigg, Woollett and Associates Ltd., Edmondton, Alberta). West. Miner, 41: 42-4; 49-53(Sept. 1968).

Uranium exploration in the Beaverlodge District has been concentrated within a twenty mile radius of Uranium City. This area is characterized by folded, cataclastically deformed metamorphosed sediments and volcanics (Tazin group), northeast trending normal faults and basins of younger, undeformed cover rocks (Martin formation). Areas outside the Beaverlodge District are actively under exploration. Large tonnages of uranium bearing pegmatites in the range 0.07 to 0.12 per cent U_3O_8 exist in the region north of Black Lake about 120 miles east of Uranium City. Considerable attention is now being devoted to exploration of the Athabasca sandstone and the unconformity at the base of the sandstone. (auth) (Canada)

4392 URANIUM AND COPPER MINERALIZATION IN THE BIG INDIAN WASH-LISBON VALLEY MINING DISTRICT, SOUTHEASTERN UTAH. Schmitt, Leonard Joseph. New York, N. Y.; Columbia Univ. (1968). 187p.

Thesis.

Stratiform uranium deposits and fault-controlled copper deposits occur along a major salt anticline on the Colorado Plateau in southeastern Utah. This study in the Lisbon Valley and Big Indian Wash areas of the Plateau was made to develop and evaluate criteria of origin. Investigation involved: temperatures of mineralizing solutions, mechanism of introduction, causes of precipitation, evidence for hydrothermal alteration, time-space relations between uranium deposition and copper deposition, and timing of ore formation. Sulfur isotopic analyses indicate that bacterial H_2S was a copper and iron precipitant and uranium reductant. Some bacterial activity was apparently coincident with ore deposition. Therefore, the upper temperature limit of the bacterial activity, about 90°C, may have been the maximum temperature of solutions which deposited iron and copper sulfides and uranium oxides. Copper ores were localized in and near faults and fractures, with Ba-Sr sulfates in places coincident. The buried Paradox Formation was the probable source of barium and a potential source of metal-carrying chloride brines. Copper was apparently introduced by solutions ascending along the Lisbon Valley fault and related fractures. Stratified uranium deposits were displaced by the Lisbon Valley and subsidiary faults, which may contain copper but not uranium ores. Apparently uranium was not introduced by solutions ascending the Lisbon Valley fault zone. Aggregates of uraninite crystallites were the same size over two miles from the Lisbon Valley fault as adjacent to the fault. Sulfur isotopic analyses of copper sulfides indicated deposition by solutions in contact with bacterial H_2S, sedimentary sulfides, or both. Variable isotopic compositions in adjacent sulfides and recognition of framboidal pyrite structures in bornite indicated that bacterial action was operative during mineralization. Masses of argillic alteration, often indicative of hydrothermal action, were not observed. Kaolinite occurred in veinlets along the Lisbon Valley fault. Dickite, a polymorph of higher thermal stability than kaolinite and often a product of hydrothermal alteration in ore deposits, was either absent or a minor phase. Uranium and copper represented two periods of mineralization. Uranium was introduced prior to major faulting. Copper introduction was coincident with or subsequent to major faulting. Radiometric ages indicated that uranium deposition occurred primarily about 200 million years ago. Galena is evidently a trap for much lead produced by uranium radioactive decay. Therefore, to ensure a close approximation to a closed radiogenic system large samples should be selected for age determinations and galena must be included. Paths of introduction for the original uranium and copper ions may differ. Copper may have originated from the central portion of the anticlinal structure and uranium from the flanks. It seems clear that ground water was a major element in the distribution of the ores. Available local criteria observed to date neither preclude nor establish sources for the original metals with a remote relationship to deep-seated igneous activity. (Diss. Abstr.) (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 4374, 4385, and 4386.

4393 (CEA-R-3851) STUDY OF THE CHIMNEY PRODUCED BY AN UNDERGROUND NUCLEAR EXPLOSION. Derlich, Serge (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Oct 1969. 18p. (In French). Dep. CFSTI (U. S. Sales Only).

Underground nuclear explosions led to the formation of a cavity which was roughly spherical in shape. The roof of this cavity was unstable and collapsed in most cases, leading to the formation of a chimney. The height and the diameter depended on the energy of the charge and on the nature of the surroundings. The chronology of various stages could be determined by seismic observations. The interior of the chimney was filled, either partially or completely, with rubble earth. This phenomenon is of great importance as far as the use of nuclear explosions for industrial applications is concerned. (auth)

4394 (PNE-954) SPECTRORADIOMETRIC DETECTION OF EFFLUENTS. Lynn, R. L.; Crandall, D. G. (EG and G, Inc., Santa Barbara, Calif.). 25 Nov 1969. 11p. Dep. CFSTI.

A scanning interferometer spectrometer was used to measure the infrared spectral signature of the radioactive effluent for the Cabriolet event. Measurements were conducted during the first three minutes after device detonation from a station six miles from ground zero. Several molecular species recognized in the effluent were O_3, CO_2, and NO_2. Other molecular species have been tentatively identified, but positive identification would require a laboratory study of the effects on the spectra of large concentrations of particulates suspended in the effluent. Background spectra from a region outside the effluent are also shown. (auth)

4395 (PNE-3014) SPECIAL REPORT ON THE HARDCORE COSTS OF PROJECTS GASBUGGY AND SCHOONER. Plowshare Program. Campbell, E. D. (San Francisco Operations Office (AEC), Calif.). Apr 1969. 21p. Dep. CFSTI.

Results of efforts to make available data on the present cost of carrying out nuclear explosions for peaceful purposes are summarized. The information was prepared in response to requests from industry and others who feel this information may be helpful in comparing the economics of utilizing nuclear explosives vs. conventional explosives or other techniques in mining, excavation, extraction of oil and gas, and other industrial endeavors. (auth)

4396 (PNE-R-11) PROJECT RULISON: DEFINITION PLAN. (Geonuclear Corp., Las Vegas, Nev.). 26 Mar 1969. 178p. Dep. CFSTI.

Plans for testing of nuclear stimulation of the Rulison gas field for subsequent commercial development are presented. Information is included on the technical plan, nuclear operations plan, safety program, administrative plan, logistics and support plan, engineering and construction plan, and task descriptions. (J.R.D.)

4397 (TID-25180) UNDERGROUND NUCLEAR TESTING. (Atomic Energy Commission, Washington, D. CC.). Sept. 1969. 59p. Dep. CFSTI.

Information of public interest on the Amchitka Island, Alaska underground nuclear tests is presented in five sections as follows: AEC preparations for the Amchitka explosions; safety of nuclear testing, including radiation and seismic safety, procedures for protecting the environment, and the AEC safety record with over 200 underground nuclear explosions; procedures required to ensure the safety of the proposed tests; history of the selection of Amchitka Island as a test site and its preparation for this purpose; and, finally, a 1968 report by the independent Pitzer Panel which studied the potential hazards associated with underground nuclear explosions. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 4426, 4616, 4832, 4863, 5105–5107, 5111–5113, 5119, and 5122.

4398 (ORNL-TM-2595) DESIGN AND OPERATION OF STAINLESS STEEL FORCED-CIRCULATION BOILING-POTASSIUM CORROSION-TESTING LOOPS. Fuller, L. C.; MacPherson, R. E. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 48p. Dep. CFSTI.

During 6000 hr of operation with five test loops, a reliable forced-circulation boiling-potassium test facility was developed and thoroughly proven. Two additional loops were then operated, one for 1000 hr and a second for over 14,500 hr. The facility and the loops operated in it were used to determine the corrosive-erosive effect of high-velocity potassium vapor on candidate materials for the fabrication of high-temperature turbine nozzles and blades. The program provided materials information needed in the development of the potassium Rankine cycle for space nuclear auxiliary power (SNAP); specimens of type 316 stainless steel, Haynes 25 alloy, and TZM alloy were tested. The potassium system containment material was type 316 stainless steel. To date a total of approximately 20,000 hr of test time has been accumulated at a nominal temperature level of 1600°F. Details of the loop design and operation are reviewed. Results of the metallurgical evaluations of the materials tested are reported separately. (auth)

4399 (UCRL-72073) FUTURE PROSPECTS FOR APPLICATIONS OF SUPERCONDUCTIVITY. Taylor, Clyde E. (California Univ., Livermore. Lawrence Radiation Lab.). 25 Oct 1969. 18p. (CONF-690623-2). Dep. CFSTI.

From Cryogenic Engineering Conference, Los Angeles, Calif.

General aspects of superconductors are discussed emphasizing future uses. Applications in magnets, electrical machinery, power transmission, and electronic devices are discussed. It is noted that He refrigeration may be a limiting factor. (J.R.D.)

4400 CONVENIENT TECHNIQUE FOR STIRRING LIQUID SODIUM. Hobdell, M. R.; Salzano, F. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Appl. Technol.: 8: 95-6(Jan 1970).

A method for stirring liquid sodium is described that overcomes the shortcomings associated with conventional electromagnetic and mechanical methods. The method employs a rotating magnetic field with no rotating equipment. The method utilizes a three-phase induction motor that consists of the rotor and the stator. In this application the rotor is replaced by a vessel containing liquid sodium. When three-phase current is supplied to the stator windings, eddy currents are induced in the liquid sodium by the resultant rotating magnetic field. The magnetic fields associated with these eddy currents interact with the rotating external field (in accordance with Lenz's law) so as to produce metal movement in the same direction as the field. The method may be employed to stir sodium at any temperature throughout the liquid range. It was found that the passage of the rated current (4A) through the field coils produced vigorous and efficient stirring. (R.C.K.)

4401 A DEMOUNTABLE CONNECTING DEVICE FOR DUCTS. Drieu, Fernand; Sibiril, Jean (to Commissariat a l'Energie Atomique). British Patent 1,171,097. 19 Nov 1969. Priority date 21 Nov 1967, France.

A demountable leak-proof connecting device for ducts or pipes located at an angle to one another is described. The device consists of two components: receiving casings which are permanently attached in a fluid-tight manner to each of the pipe ends which are to be connected, and a preshaped connecting pipe section bearing at each end a permanently attached fluid-tight cylindrical terminal portion which fits into each receiving casing. Each receiving casing has an upwardly open semi-cylindrical recess and a plane sealing face perpendicular to the pipe axis and through which the pipe enters the casing. The connecting pipe terminal portion drops into the receiving casing, mates flush with the inside sealing face of the casing, and is sealed by pressure exerted on the sealing faces by a rod threaded through the casing end opposite the pipe entrance end. The threaded rod is coaxially aligned with the pipe. This demountable leak-proof device has the advantages of automatic alignment of the connections due to the shape of the receiving casings and the terminal inserts, and the connecting and sealing operations can be accomplished easily by remote manipulators. This last feature is particularly important when pipe connections are required within toxic or radioactive atmospheres. (L.C.L.)

4402 GERMANY'S FIRST NUCLEAR SHIP. Shipping World Shipbuilder; 162: 427-32(Mar 1969).

A description is given of the 16,870 gross tonnage ship, Otto Hahn, including principal particulars, general arrangement, machinery, reactor installation, pressure vessel and shielding, service room, and control room. The ship has an advanced 38 MW PWR (Babcock/Interatom), giving 500 days at full power. (UK)

4403 IMPROVEMENTS RELATING TO SHAFT SEALS OF BLOWERS, PARTICULARLY THE CIRCULATING BLOWERS OF GAS-COOLED NUCLEAR REACTOR PLANT. **(to Sulzer Brothers Ltd.). British Patent 1,172,030. 26 Nov 1969. Priority date 12 Oct 1966, Switzerland.**

A liquid shaft seal is described which operates in conjunction with a gas barrier. The seal may be used with shafts which operate blowers in reactor gas cooling systems. A method is provided for removal and replacement of the seal and the barrier. The design is such that radioactive contamination of the seal is prevented. (J.R.D.)

4404 A 500 W HYDROGEN REFRIGERATOR. **Croft, A. J. (Clarendon Lab., Oxford); Robertson, C. W. Cryogenics: 9: 365-8(Oct 1969).**

A 500 W hydrogen refrigerator has been installed to cool a neutron source in a UKAEA reactor. Details are given of the design of the refrigerator and of the control system which enables it to run for long periods unattended. Ortho-para conversion is the suggested explanation for the unexpectedly large loss in the original transfer line. (auth) (UK)

4405 IRRADIATION CHAMBER. **Wiesendangen, A. K. (to Sulzer Brothers Ltd.). Canadian Patent 817,980. 15 Jul 1969. Priority date 8 Sep 1964, Switzerland.**

The irradiation chamber comprises a roof having a shielding block carried therein, a floor spaced from the roof to define a space for mounting the material to be irradiated, a radiation source retractably mounted in the shielding block for movement into and out of the space between the roof and floor, and a helical tube for moving the source into and out of the space. The source is a chain of articulated capsules suitably joined and mechanism for controlling it is described. (F.S.A.)

Heat Transfer and Fluid Flow

Refer also to abstracts 4506, 5120, and 5523.

4406 HEAT TRANSFER TO MERCURY FLOWING IN LINE THROUGH AN UNBAFFLED ROD BUNDLE: EXPERIMENTAL STUDY OF THE EFFECT OF ROD DISPLACEMENT ON ROD-AVERAGE HEAT TRANSFER COEFFICIENTS. **Hlavac, P. J.; Dwyer, O. E.; Helfant, M. A. (Brookhaven National Lab., Upton, N. Y.). J. Heat Transfer, 91: 568-80(Nov. 1969).**

An experimental study of heat transfer to mercury flowing in line through an unbaffled rod bundle was carried out. The rods were special electrical heaters whose claddings had different thicknesses and thermal conductivities. The experiments were carried out under a thermal boundary condition approaching that of uniform heat flux in all directions at the inner wall of the rod cladding. It was found that displacement of a rod from its symmetrical position can result in a large reduction in its average heat transfer coefficient. This reduction increases exponentially with the amount of displacement. For a given direction and amount of displacement, the reduction is little affected by variations in cladding thickness and conductivity but is affected considerably by flow rate. Not only does the displaced rod suffer a reduction in its own average heat transfer coefficient, but so do those toward which it is displaced. At the same time, the average coefficients of the rods from which it is displaced remain about the same. Thus the overall average coefficient of the group of affected rods goes down when a single rod is displaced. (auth)

4407 BUBBLE GROWTH IN TRANSIENT POOL BOILING. **Yesin, A. O.; Jeffers, D. E. (Univ. of Manchester, Eng.). J. Brit. Nucl. Energy Soc.; 8: 267-74(Oct 1969).**

Bubble growth rates were measured by high-speed photography (55,000 frames/sec) in subcooled boiling of water on an exponentially heated platinum strip. Subcoolings ranged from 1 to 40°C and exponential periods from 1 to 6 ms. The bubbles showed an initial fast growth followed by a slower growth when the radius was proportional to the square root of the time from nucleation. Analytical expressions were found for the bubble radius in the slower growth period. (auth)

4408 GAMMA-RAY ONE-SHOT-COLLIMATOR MEASUREMENT OF TWO-PHASE-FLOW VOID FRACTIONS. **Gardner, R. P.; Bean, R. H.; Ferrell, J. K. (North Carolina State Univ., Raleigh). Nucl. Appl. Technol.; 8: 88-94(Jan 1970).**

Equations are derived to determine the optimum design parameters (minimum error) for the gamma-ray one-shot-collimator method of measuring average void fractions in two-phase flow. A compromise is indicated between the desirability of response linearity on the one hand and maximum sensitivity on the other. Results from a prototype gage using the 60-keV gamma-rays from ^{241}Am are given for void fractions of extreme distributions within a circular channel and are compared to a previous gage that used a ^{170}Tm source. (auth)

Isotope Technology

Refer also to abstracts 4209, 4376, 4426, 4440, 4633, 4840, and 4849.

4409 (IEA-158) ISOTOPE PRODUCTION AND ACTIVATION ANALYSIS USING RESEARCH REACTORS. **Lima, Fausto W. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jun 1968. 31p. (CONF-671223-1). Dep. CFSTI (U. S. Sales Only).**

From Study Group Meeting on Research Reactor Utilization, Bogota, Colombia.

The utilization of research reactors in isotope production and activation analysis, are discussed. Special conditions inherent to new nuclear centers, specifically in developing countries, are emphasized. Types of problems that must be solved for a routine production and distribution of isotopes are considered. (auth)

4410 (SGAE-PH-85/1969) ION SOURCES FOR THE ELECTROMAGNETIC ISOTOPE SEPARATOR AT SEIBERSDORF. **Wotke, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1969]. 12p. (CONF-690625-8). Dep. CFSTI (U. S. Sales Only).**

From International Conference on Ion Sources, Saclay, France.

For the various applications of the electromagnetic isotope separator, two different types of ion sources of the low voltage, low pressure, arc discharge type with side extraction are used. The first one with circular beam extraction geometry is of the magnetron type and the second one, for slit geometry, uses two filaments parallel to the extraction slit and providing ion beams up to 10 mA and more. (auth)

4411 SOLUTION ABSORPTIOMETRY WITH BETA EXCITED SOURCES BY MEANS OF BALANCED FILTERS. **Toothacker, William S.; Preuss, Luther E. (Edsel B. Ford Inst. for Medical Research, Detroit). Advan. X-Ray Anal., 12: 439-45(1969).**

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

The use of beta excited x-ray sources in solution absorptiometry has been reported. These sources produce characteristic K x-ray lines superimposed upon a bremsstrahlung continuum. When the entire beta excited spectrum was used the resulting plots of ln (I_0/I) versus concentration of solute were not straight lines (I_0 is the intensity of the x-rays after passing through the solvent, and I is the intensity after passing through both the solvent and solute) but curved downward, as is characteristic of polychromatic sources due to preferential absorption of the low energy photons. These sources have a bremsstrahlung end-point equal to the beta energy E-max. This continuum energy usually is relatively high, resulting in a high mean x-ray energy for the polychromatic beam. This is not a desirable condition. Ideal sources for absorptiometry would be monochromatic in nature with an overall energy range covering the K_α values for the elements. The use of a monochromatic source has two advantages for solution absorptiometry. First, the sensitivity is much greater since the K peak is of lower energy than the bremsstrahlung continuum. Secondly, the plot of ln (I_0/I) versus solute concentration is a straight line since a fixed value of the mass absorption coefficient can be assigned to this fixed energy, thus simplifying calibration. To use only the monochromatic K energy from these beta excited sources, we have applied the method of balanced filters. These monochromatic K x-rays, with the remainder of the continuum filtered out, have been employed in solution absorptiometry. The resulting plots of ln (I_0/I) versus solute concentration are straight lines with very good sensitivity. Using this technique, a very wide range of monochromatic energies are available for use in solution absorptiometry. (auth)

4412 RECENT INDUSTRIAL RADIOISOTOPE APPLICATIONS IN NORWAY. **Dahl, J. B. Atoomenergie Haar Toepass., 11: 248-51(Oct. 1969).**

Some typical applications of radioisotopes in Norwegian industries are reviewed. Radioisotope tracer techniques are a versatile tool in water flow measurements in connection with hydroelectric power generation. Tracer techniques were also useful in all kinds of mixing and material transport studies for experimental chemical reactors and in the paper industry. In air and water pollution studies radioisotopes were used effectively. Routine radioisotope dilution techniques were used for the determination of mercury in chlorine-alkali electrolysis cells. (G.M.C.)

4413 GAS CENTRIFUGE. **(to Doryokuro Kakunenryo Kaihatsu Jigyodan). British Patent 1,171,998. 26 Nov 1969. Priority date 29 Mar 1966, Japan.**

A gas centrifuge for separating isotopes of gases of different molecular or atomic weight is described. The centrifuge comprises a fixed outer chamber and a cylinder inside the chamber which rotates at high velocity. Uranium-235 may be separated from UF$_6$ by feeding it into the cylinder. The ^{235}U collects in the lower end of the cylinder and depleted gas collects in the upper end of the cylinder. (J.R.D.)

Materials Testing

Refer also to abstracts 4209, 4510, 4710, and 4711.

4414 (ORNL-4440, pp 155-9) NONDESTRUCTIVE TEST DEVELOPMENT. Harms, W. O.; McClung, R. W. (Oak Ridge National Lab., Tenn.).

New techniques and equipment for nondestructively testing materials and components are being investigated. Analytical work on electromagnetic phenomena has been directed in part to the design of improved cells for measuring conductivity more accurately. Coil impedance is being measured as affected by the presence of defects in a tank of Hg to verify the mathematical theories previously derived. Sample welds containing flaws are being fabricated for study with the ultrasonic schlieren system. Studies using frequency analysis included observing frequency spectra as a function of the size of the aperture of the collimator. Specimens were prepared for frequency analysis of reflections as a function of reflector size and orientation. (auth)

4415 PRINCIPLES FOR EXECUTION OF TENSILE AND CREEP TESTS IN A VACUUM AT HIGH TEMPERATURE. Bollenrath, F.; Feldmann, H.; Happek, G. (Technische Hochschule, Aachen). pp 998-1015 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The present state of development of the methods used for various tests for tensile and creep studies at high temperatures in vacuum, characterized by research devices and procedures which often permit no direct comparison of the research results. For its evaluation the sources of error of the method must be known. The research conditions of vacuum, power initiation, expansion measurements, expansion rate, temperature, and temperature distribution were studied. The pressure in the vacuum chamber and the leak rate should be considerable for the research materials. Inhomogeneous deformations distributed over the sample cross section and measurement length, relative motions between sample and test machine or expansion measurement device, and temperature expansion could not be detected individually and were eliminated. The power initiation in the vacuum chamber and the sample must be followed so that additional stresses remain as low as possible. The expansion rate of the measurement length was strongly affected by the shape of the test device at constant escape rate of the traverse. The drive must therefore be so operated that the expansion rate in the measurement gap remains constant. An accurate expansion measurement is necessary during the tensile studies for the expansion rate control. Elasticity and expansion limits were determined higher at constant expansion rate at room temperature than at constant stress rate of the traverse. The effect of the temperature deviations in the measurement length on the material characteristics was described. For evaluation of the measurement methods, test norms, and materials and for the measurement of constituents it is necessary to know how reliable the resistance characteristics are. The relative resulting stress error is given as a function of the affecting parameters (expansion, temperature, expansion rate) and dimensionless error moduli. Properties determined in tensile and creep studies of various work materials are reported. (tr-auth)

Radioactive Material Handling

4416 (DPSPU-69-124-3) SAFETY SUMMARY REPORT: SCRAP GRAPHITE CONTAINER (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Rogers, R. F. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Nov 1969. Contract AT(07-2)-1. 13p. Dep. CFSTI.

Graphite containing small amounts of uranium, shipped in a Specification 6J steel drum, complies with AEC Manual Chapter 0529, Safety Standards for the Packaging of Radioactive and Fissile Materials. The drum (package) does not represent a radiological or criticality hazard under normal or accident conditions. (auth)

4417 AN AUTOMATIC COLLECTOR OF LIQUID FRACTIONS. Cardinaud, Robert; Desmares, Jean (to Commissariat a l'Energie Atomique). British Patent 1,164,755. Sept. 24, 1969. Priority date Mar. 24, 1967, France.

An apparatus is described for collection of liquid fractions continuously and automatically from a distributor or similar element delivering these fractions drop by drop. The apparatus is particularly applicable to radioactive liquids. The collector comprises at least one tube-carrying ring mounted on a vertical axis and movable about the axis. Means are provided for actuating and controlling the discontinuous rotation of the ring so that the tubes pass one by one beneath a distributor of the liquid fractions of a given volume. The ring is associated with a coaxial parallel plate disposed below the tubes. This plate has at least one recessed part for collection of liquid not received or retained by the tubes and has an electric detection element sensitive to the presence of liquid for halting the distribution of liquid fractions. Provision is also made for the ring to contain several concentric rows of tubes for holding more fractions. (B.L.M.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 4381, 4515, 5369, and 5553.

4418 (AD-691204) PROBLEM H01-32: AIRBORNE RADIAC. Progress Report, February 29–December 31, 1968. Peters, Charles W. (Naval Research Lab., Washington, D. C.). Feb. 1969. 40p. (NRL-MR-2001). CFSTI.

The preliminary investigation of the technical feasibility of using an airborne radiation detector to measure the ground level dose rate over a fallout field after the fallout cloud has passed is described. Several detector designs were investigated to determine which would be best for use as an airborne radiac. Two NaI scintillation counters were tested at the U. S. Army Nuclear Defense Laboratory at altitudes up to 5,000 feet over large point sources to corroborate the preliminary calculations. A breadboard detection system based on these preliminary calculations and measurements is proposed. (auth) (USGRDR)

4419 (CEA-R-3886) TRITIUM METROLOGY IN A TOTAL ABSORPTION IONIZATION CHAMBER. Blondel, Maurice; Dalmazzone, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1969. 31p. (In French). Dep. CFSTI (U. S. Sales Only).

Because of its low maximum energy (18 keV), the beta spectrum of tritium can be measured in an ionization chamber with total absorption and fixed sensitive volume. The results obtained are compared with those given by an absolute measurement using a differential counter. They confirm the possibility of making simple and rapid tritium measurements within a wide range (1 millicurie to 100 curies) with a precision of ±1.5 percent. (auth)

4420 (CEA-R-3899) α EMITTERS MEASUREMENT BY DEFINED SOLID ANGLE METHOD. Perolat, Jean-Pierre; Gorry, Jeanne (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1969. 17p. Dep. CFSTI (U. S. Sales Only). (In French)

The principle for absolute measurement of α particle is described. Scattering, backscattering and absorption corrections are reviewed as well as the different sources of errors of this method. Two low geometry counters are used, the first with a geometry factor of about 2×10^{-2}. Using the second counter, by a suitable design of the head of detection, it is possible to choose one of the four geometry factors: 1.8×10^{-4}, 4.4×10^{-5}, 1×10^{-5} or 1×10^{-6}. The comparison of these two counters and the comparison of the first of them with a 4π $\alpha-\gamma$ coincidence system confirm the fact that this method allows to obtain accuracies better than 0.2 percent. (auth)

4421 (CEX-65.60) NEUTRON SPECTROMETRY: OPERATION HENRE (PROGRAM 6). Sanna, Robert S.; McLaughlin, James E.; Lazanoff, Arthur; O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1969. 40p. Dep. CFSTI.

Measurements of neutron spectra with nuclear emulsions at various distances from a 14 MeV neutron source were made at the Nevada Test Site during Operation HENRE. These measurements and supplementary ones made using the neutron-flux integrator developed at the Lawrence Radiation Laboratory, and a version of Bonner's spectrometer, are compared with theoretical calculations. Overall agreement was found to be good. (auth)

4422 (IEA-171) MONTE CARLO CALCULATION OF MONOCHROMATIC GAMMA-RAYS ENERGY LOSS: APPLICATION FOR NaI(Tl) CRYSTALS. Franzen, H. R.; Mafra, O. Y.; Bianchini, F. G. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Aug 1968. 49p. Dep. CFSTI (U. S. Sales Only).

A program (GINASB) using the Monte Carlo Method for calculating the energy loss spectra of monoenergetic gamma rays in NaI(Tl) is described, taking into account the following primary interaction effects: Rayleigh, photoelectric, Compton and pair production. The method can be applied to circular cylinders of various diameters and heights. This program supplies the energy loss spectra for point sources, broad and collimated parallel beams, and for incident gamma ray of energies from a few keV to 4 MeV. The experimental resolution effect was taken into account by another program (STRECH). Both programs were written in Fortran-II-D for the IBM 1620-II Computer. Lists of the programs, GINASB and STRECH, functions and subroutines are presented. A comparison between the calculated photo-fraction efficiencies and the energy loss-spectra with the experimental data is also presented. (auth)

4423 (LA-4251) EXTREME ULTRAVIOLET AND SOFT X-RAY DETECTOR DEVELOPMENT FOR VELA SATELLITES. Blocker, N. K.; Chambers, W. H.; Fehlau, P. E.; Fuller, J. C.; Kunz, W. E. (Los Alamos Scientific Lab., N. Mex.). 5 Sep 1969. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Development of satellite-borne instruments to measure radiation of wavelength 0.3 to 1350 Å is discussed. These devices were flown on the Vela satellites, Launches III, IV, and V, beginning in 1965. In this portion of the Vela program, emphasis has been placed on long-term monitoring and detection of solar and space radiation rather than on high resolution measurements. Four types of instruments were developed including a Lyman-α detector employing an ion chamber, a retarding-potential analyzer, ion chambers for soft x-rays, and a scintillator-photomultiplier. The design, construction, and calibration of the instruments are described, together with brief comments concerning on-orbit operation and data retrieval. (auth)

4424 (SRRC-33/69) AN ASSESSMENT OF THE INFLUENCE OF ^{60}Co CONTAMINATION IN STRUCTURAL STEEL, OF THE McMASTER UNIVERSITY HEALTH SCIENCES COMPLEX, ON THE BACKGROUND COUNTING-RATE OF THE PROPOSED SHADOW-SHIELD WHOLE-BODY MONITOR. Boddy, Keith; Mahaffy, Maureen E. (Scottish Research Reactor Centre, East Kilbridge (Scotland)). [nd]. 21p. Dep. CFSTI (U. S. Sales Only).

Samples of steel to be used in constructing the McMaster University Health Sciences Complex were examined for known cobalt-60 contamination. The activity was estimated as about 0.2 pCi/g steel. The effect of the contamination on the background counting-rate of the shadow shield whole-body monitor proposed for the Complex was simulated. A millicurie ^{60}Co source was placed at positions in horizontal matrices at 3 vertical heights to allow appropriate interpolation to the influence of horizontal and vertical girders at known positions relative to the monitor. At each position the increase over background counting-rates was measured in 8 energy bands of clinical interest. Approximate computations led to the conclusion that excess counting-rates over background are unlikely to be statistically significant and should not unduly affect the performance of the monitor. (auth)

4425 DESIGN AND OPERATION OF A FAST 2π GAS-FLOW COUNTER FOR ALPHA PARTICLES. Yeates, D.; Harris, S.; Doust, C.; Parish, H. (Univ. of Surrey, Guildford, Eng.). J. Phys., E (London); 2: 1098-1100(Dec. 1969).

It is stated that the accurate measurement of high emission rates of alpha radioactive sources has been neglected up to the present time. In order to resolve this difficulty a new 2π proportional counter was developed, capable of measuring up to at least 5×10^5 alpha particles per second into 2π geometry. Careful attention was devoted to the factors limiting counting speed, notably mechanical and electrical design of the counter and preamplifier circuitry. The choice of counting gas was also critical for high speed applications. The calibration of the counter was checked using a certified standard source emitting 1.029×10^5 alpha particles per minute. The measured emission rate of the source agreed to within ±0.1% of this figure. (auth) (UK)

4426 STANDARDIZATION OF GAMMA-RAY RADIATION SOURCES AND PORTABLE SURVEY METERS IN THE RESTRICTED AREA. I. Lim, Yong Kyu; Ro, Seung Gy; Lim, Woo-yong (Atomic Energy Research Inst, Seoul). New Phys. (S. Korea); 9: 24-8(Jun 1969). (In Korean).

A method for standardizing gamma-ray radiation sources and portable survey meters in a restricted area, namely, a room surrounded by 30 cm thickness of concrete and 7.9 m × 5.8 m × 3.7 m(H) in its inner dimension is presented. Scattering effect of Co-60 and Ra-226 gamma-ray was minimum at the radiation source-detector distance (D) of 0.6 to 0.7 m and the concrete floor-to-detector height (H) of 1 m. And also the effects due to self-absorption, air build-up, and geometrical factors were negligible in this configuration when other scattering objects were not close to the radiation source or the detector. (auth)

4427 A QUENCHING CIRCUIT OF VERY SHORT RISE TIME FOR GEIGER-MUELLER COUNTERS. Eckey, H. (Univ., Munich). J. Phys., E (London); 2: 1121-2(Dec 1969).

A simple quenching circuit is described which reduces the dead time of Geiger-Mueller counters by lowering the anode voltage immediately after the beginning of the discharge. The circuit delivers negative pulses with 300 V amplitude and 28 ns rise time. This extremely short rise time had not so far been achieved with similar circuits. (auth) (UK)

4428 COMMENTS ON THE USE OF LIQUID SCINTILLATION FOR ROUTINE DETERMINATION OF ^{14}C ACTIVITY IN PRODUCTION STUDIES. Lind, Owen T.; Campbell, Robert S. (Univ. of Missouri, Columbia). Limnol. Oceanogr; 14: 787-9(Sept 1969).

Liquid scintillation was used for detection of ^{14}C activity of algae in primary production and pesticide bioassay investigations. A description of modifications of the basic procedure with emphasis on automatic external standardization is given. The procedure is evaluated and criticized. It is recommended because of high efficiency, high sensitivity, and simplicity of sample preparation. (H.L.W.)

4429 RADIATION IMAGING SYSTEMS AND METHODS OF OPERATION THEREFOR. (to Westinghouse Electric Corp). British Patent 1,170,074. 12 Nov 1969. Priority date 14 Oct 1965, United States.

The design and operation of a scintillation gamma camera with an image intensifier system for high-resolution radiodiagnosis are described. (W.H.K.)

4430 GEL SUSPENSION COUNTING OF BARIUM CARBONATE-^{14}C. Turner, J. C. (Radiochemical Centre, Amersham, Eng.). Int. J. Appl. Radiat. Isotop., 20: 761-6(Nov. 1969).

Gel suspension counting of barium carbonate-^{14}C using the channels ratio method of determining counting efficiency was investigated. Determination of the specific activity of the material is not affected by variations in the particle size of the suspensions, unless large quantities of coarse material (up to 2–3 mm dia.) are counted, and self-absorption is constant from sample to sample. The self-absorption factor for barium carbonate-^{14}C was accurately measured. Gel suspension counting under the same conditions was shown to be unreliable for a crystalline material, D-glucose-^{14}C(U), as large variations in self-absorption occurred with variations in particle size. (auth) (UK)

4431 ANNEALING OF TRACKS FROM FRAGMENTS OF FISSION NUCLEI IN SOLIDS. Geguzin, Ya. E.; Vorob'eva, I. V. (Kharkov State Univ.). Ukr. Fiz. Zh., 14: 1499-1505(Sept. 1969). (In Russian).

A two-zone model of structure of tracks from fragments of heavy charged particles is given. Estimations are given of the track curing kinetics in supposition that the viscous flow or directed self-diffusion is the determining mechanism of mass transfer. The estimations presented are compared with the results of experiments on curing tracks in glasses and tectites. Such comparison testifies to the two-zone model of the track. (auth)

4432 PARTICLE TRACK ENHANCEMENT IN CELLULOSE NITRATE BY APPLICATION OF AN ELECTRIC FIELD. Crannell, Hall; Crannell, Carol Jo; Kline, F. J.; Battist, Lewis (Catholic Univ. of America, Washington, D. C.). Science, 166: 606-7(Oct. 1969).

The number and length of etchable tracks, created by alpha particles in a cellulose nitrate sheet, are significantly enhanced by the application of an electric field across the cellulose nitrate. (auth)

4433 SAMPLE CHANGING ELEVATOR AND LIGHT SEALING MECHANISM FOR SCINTILLATION COUNTING. (to Beckman Instruments, Inc.). British Patent 1,167,204. 15 Oct 1969. Priority date 11 Apr 1966, United States.

A sample changing elevator and light sealing mechanism for moving a sample vial from one horizontal plane to another from a sample conveyer to a liquid scintillation counting system are described. (W.H.K.)

4434 EFFECT OF DIFFERENT NOISE SOURCES ON THE TIME RESOLUTION OF Ge(Li) DIODES. Miehe, J. A.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods; 75: 328-30(1969). (In French).

Timing properties of planar and coaxial counters are studied. The influence of both series and parallel noise sources is clearly shown. Fwhm of the coincidence curves of 1.6 ns (^{22}Na) for planar detectors and 3.4 ns for coaxial counters have been obtained (w = 7–8 mm). (auth)

4435 GEOMETRIC RESOLUTION OF POSITION-SENSITIVE DETECTOR. Picot, A. (Laboratoire de Physique des Milieux Ionises, Nancy). Nucl. Instrum. Methods; 75: 323-4(1969). (In French).

The divergence between theoretical (exponential spectrum) and experimental results which gives the geometrical resolution of a position sensitive detector is discussed for an axial flux of α particles. (auth)

4436 ELECTRONIC FUNCTION GENERATOR FOR CHARGED PARTICLE IDENTIFIER TECHNIQUES. Bateman, J. E.; Mundell, J. B. (Univ. of Glasgow). Nucl. Instrum. Methods; 75: 320-2(1969).

An electronic function generator is described which permits mass discrimination of the charged particle traversing a silicon detector telescope. The generator, which is based on the principle of piecewise linear interpolation, provides a level of performance similar to that achieved by logarithmic circuits while retaining the advantages of simplicity. (auth)

4437 THEORETICAL EXPLANATION OF A NEW TRIGGERING METHOD. Hartmann, G.; Klein, J. W. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Nucl. Instrum. Methods; 75: 317-19(1969).

A theoretical explanation of a new triggering method, published by S. Kinbara and T. Kumahara, is given. It is shown, that the method is not applicable to arbitrary pulse shapes. Conditions are given, for which the method provides a time determination independent of rise time and amplitude of the pulse. The surface barrier detector pulse shape is treated as an example. In the case of the Ge(Li) detector, these conditions are not fulfilled. (auth)

4438 OVERLOAD CANCELLATION CIRCUIT FOR A CHARGE-SENSITIVE PREAMPLIFIER. Satterfield, M. M.; Dyer, G. R.; McClain, W. J. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 75: 312-16(1969).

An active circuit which prevents saturation due to overloads in a charge-sensitive preamplifier is presented. Cosmic rays often produce relatively bright scintillations in a detector, especially if the crystal is large. The resulting overload may saturate the preamplifier, significantly increasing the dead time of the system. To reduce this undesirable effect, an active stage containing a field-effect transistor is inserted in parallel with the normal feedback network of the charge-sensitive preamplifier. This stage prevents an excessive charge from being deposited on the feedback capacitor and thereby prevents blocking in the preamplifier and permits a prompt return to linear operation. A description of the operation of the circuit and results of tests are included. (auth)

4439 THEORY OF COMPENSATION IN LITHIUM DRIFTED SEMICONDUCTOR DETECTORS. Lauber, A. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods; 75: 297-308(1969).

The lithium ion drift method produces detectors with a highly but not perfectly compensated intrinsic region. The amount of fixed space charge left in the compensated layer and its dependence on drift and clean-up parameters is of great practical interest. The imperfect compensation is mainly due to the presence in the compensated layer of thermally generated electron-hole pairs swept apart by the voltage applied to the detector during drift. A theoretical model is developed which takes into account the influence on the fixed space charge of mobile carrier generation and recombination. When recombination of free electrons and holes is negligible the theory predicts the formation of linear space charge gradients. When recombination is strong a constant space charge throughout a large part of the compensated layer may result. The theoretical calculations are compared with experimental findings. The influence of space charge on detector performance is discussed. (auth)

4440 NEARLY MONOENERGETIC SOURCE OF 6.129 MeV GAMMA RAYS FOR Ge(Li) DETECTOR CALIBRATION. John, Joseph; Orphan, V. J.; Hoot, C. G. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Instrum. Methods; 75: 271-3(1969).

A simple method of producing a source of high energy gamma rays is described. The gamma rays are obtained from the decay of ^{16}N nuclei that have been produced by the reaction ^{16}O(n,p)^{16}N. The 6.129 MeV gamma ray is completely free of distortion, Doppler broadening, and energy shift. Except for the presence of about 7% of 7.117 MeV gamma rays, this source is essentially monochromatic and provides an excellent means of studying the line shape of a Ge(Li) detector. (auth)

4441 IMAGE TUBE FOR CONVERTING THERMAL NEUTRON FLUX DISTRIBUTION PATTERNS INTO AN OPTICAL IMAGE OR INTO VIDEO SIGNALS. (to Thomson-CSF). British Patent 1,168,564. O69. Priority date Apr. 22, 1966, France.

An image tube for converting thermal neutron flux distribution patterns into an optical image or into video signals is described. A scintillation element made of luminescent material mixed with a substance containing a boron component which is capable of liberating ionized particles under the effect of neutron bombardment is used in association with a photo-cathode, characterized in that the scintillation element and the photo-cathode cover the two faces of a common optically transparent carrier placed inside an evacuated envelope which is transparent vis-a-vis thermal neutrons, and in that the substance mixed with the luminescent material is such as to ensure that the mixture adheres to the transparent carrier. (W.H.K.)

4442 IN-LINE D_2O ANALYSIS. Stutheit, J. S.; Rampey, W. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Instrum. Methods; 75: 43-4(1969).

A technique has been developed for in-line monitoring of D_2O concentration in process streams. Commercially available neutron counters are used to detect neutrons from deuterium in water irradiated with 2.62 MeV gamma rays [$^2_1D(\gamma,n)^1_1H$]. Using this technique, deuterium concentrations from 0.015% to 0.13% D_2O in water were measured in laboratory tests with an accuracy of 1% in 30 min. A source-detector configuration was developed and the proposed system successfully tested in the laboratory. The technique was not applied in the existing heavy water plant because of a shortage of funds, and because justification for modification of existing towers was insufficient. Use of the technique for new plants, where towers could be designed initially to include such an instrument, should be much more economically advantageous. (auth)

4443 RADIATION MONITOR. May, C. P.; O'Hara, K. A. (Westminster Hospital, London). Nucl. Instrum. Methods; 75: 178-80(1969).

A simple radiation monitor with an extremely linear ratemeter is described which covers a wide range of counting rates. The input circuit is very sensitive and can operate from 100 mV pulses. (auth)

4444 THE PREPARATION AND PERFORMANCE OF THIN VACUUM-DEPOSITED CsI(Na) SCINTILLATION LAYERS. van der Ven, H. W. (EURATOM-FOM, Jutphaas, Netherlands). Nucl. Instrum. Methods; 75: 347-8(1969).

The preparation of thin vacuum-deposited CsI(Na) scintillation layers is described. The scintillation response of these layers is similar to the response of thicker NaI(Tl) crystals for 5.9 keV x-rays. (auth)

4445 MEASUREMENT OF THE ABSOLUTE SCINTILLATION EFFICIENCY OF GRANULAR AND GLASS NEUTRON SCINTILLATORS. Spowart, A. R. (United Kingdom Atomic Energy Authority, Caithness, Eng.). Nucl. Instrum. Methods; 75: 35-42 (1969).

Measurements of the absolute scintillation efficiency of granular and glass neutron scintillators have been made by activating the scintillators in a parallel collimated thermal neutron beam. The values found for the optimized forms of the scintillators are (25 ± 2) eV/photon for the granular neutron scintillator and (510 ± 40) eV/photon for the glass neutron scintillator after correction for the epithermal neutron, fast neutron and gamma ray contributions to the activation. The variation in value of the absolute scintillation efficiency with scintillator composition and thickness is shown by measurements on a variety of both glass and granular scintillators. (auth)

4446 NANOSECOND TIMING FOR A LARGE LIQUID SCINTILLATOR. Hockenbury, R. W.; Moyer, W. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Instrum. Methods; 75: 45-7(1969).

A description is given of the fast-slow coincidence system now used with a 1.25 m liquid scintillation detector for keV neutron capture measurements at the Rensselaer Linac Laboratory. (auth)

4447 AN INPUT-CAPACITY-INSENSITIVE, CHARGE-SENSITIVE PREAMPLIFIER FOR SIMULTANEOUS USE IN VACUUM WITH FAST AMPLIFIERS FOR CHARGED-PARTICLE STUDIES WITH SEMICONDUCTOR DETECTORS. Hill, N. W.; Albritton, W. P. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 75: 18-28(1969).

A low-noise, charge-sensitive preamplifier was designed for service in a system used for experimental studies of charged particles with the Oak Ridge Isochronous Cyclotron 60-MeV proton beam. In these studies all charged particles from 1 to 60 MeV produced in targets bombarded by 60-MeV protons were examined and identified by an on-line computer using two methods simultaneously: time-of-flight mass identification, and E by dE/dx mass and charge identification. The first method requires a detector and preamplifier system that can resolve the ~3-nsec flight-time difference between 10 MeV ^{3}He and alpha particles. The second method requires a system with an energy resolution of 100 keV for 60-MeV protons. The charge-sensitive preamplifier described herein meets these requirements with good versatility and without sacrificing other performance characteristics. The preamplifier consists of a charge-sensitive loop only. Its charge sensitivity is from 54 mV/MeV (in Ge) to as much as 2 V/MeV with from one to three FET's in parallel at the input without the addition of parasitic suppressors. For 1.6-μsec RC-RC pulse shaping, the measured noise of this preamplifier at room temperature is 1.1 keV fwhm (referred to Ge), measured with zero detector capacity but with all other connections made, including a 1-pF test pulse capacity. An input pulse of either polarity is accepted; the maximum output is either ±3.0 V into 93 Ω with better than 0.05% linearity. The temperature stability is better than 0.05% from −10° to 50°C, and as measured is determined by the temperature stability of both the charge injection capacitor and the feedback capacitor. The gain stability under prolonged vacuum operation inside a scattering chamber is better than 0.05% for 5 h. To increase the signal received by the fast amplifiers used simultaneously with this charge-sensitive preamplifier and to minimize the loop closure time, no bandwidth suppression is used even for the larger feedback ratios with three FET's. Under these conditions the preamplifier is stable against parasitic oscillations with input cable impedances from 50 to 125 Ω, cable lengths continuously variable from 0 to 4 ft, and input capacities at the ends of these cables from zero to several hundred picofarad. One of the necessary design considerations achieved with this preamplifier is that the dc bias conditions are adequate to ensure linear operation over the large dynamic range of energies expected. This includes energy depositions of ~16 MeV in a 100-μ diode, whose collection time is faster than the response time of the charge-sensitive loop. The design also includes an internal feedback network which when adjusted permits the preamplifier to operate with a detector capacitance from 0 to 100-pF with no detectable change in the output pulse amplitude. (auth)

4448 IMPROVEMENT OF A MULTICOUNTER GONIOMETER FOR GAMMA-GAMMA ANGULAR CORRELATION MEASUREMENTS. Okano, K.; Kawase, Y.; Uehara, S.; Hayashi, T. (Kyoto Univ.). Nucl. Instrum. Methods; 75: 159-60(1969).

A multicounter goniometer previously reported has been improved to increase the efficiency of the system and was successfully applied for gamma-gamma angular correlation measurements of short-life nuclei such as 43 sec ^{104}Rh. (auth)

4449 ELECTRON RESPONSES AND INTRINSIC LINE-WIDTHS IN NaI(Tl). Prescott, J. R. (Univ. of Calgary, Alberta); Narayan, G. H. Nucl. Instrum. Methods; 75: 51-5(1969).

Experimental measurements and calculations of the response of thallium activated sodium iodide to electrons and gamma-rays are assessed. It is concluded that in spite of generally good agreement between measurements of electron response, it is still not possible to make good quantitative calculations of intrinsic line-width in scintillation counters. (auth)

4450 WILSON EXPANSION CLOUD CHAMBER FOR OPERATION ON AN ELECTRON LINEAR ACCELERATOR. MacLeod, A. M. (Univ. of Glasgow). Nucl. Instrum. Methods; 75: 56-60(1969).

A discussion is given of the suitability of the Wilson expansion cloud chamber for present day nuclear physics experiments. A description is given of the Glasgow chamber, planned for the study of photonuclear reactions above the giant resonance, using the positron annihilation spectrum from the electron linac at the Kelvin Laboratory. The performance of this chamber is discussed for a balanced overcompression cycle and for a modified overcompression cycle which was found to be more suitable with high beam intensities. (auth)

4451 FLUX WITHIN A SHIELDED RIGHT-CIRCULAR CYLINDER EXPOSED TO PROTONS IN SPACE. Huetter, G. T.; Madey, R. (Clarkson Coll. of Tech., Potsdam, N. Y.). Nucl. Instrum. Methods; 75: 113-16(1969).

An analytic expression has been found for the unidirectional integral flux density on the axis of a long, thin, cylindrical shell shield exposed to space protons. An analytic expression has also been obtained for the flux of protons at a point within a right-circular cylinder of radius r and height h that is shielded from an isotropic flux density of protons by a long, thin, cylindrical-shell shield. (auth)

4452 TIMING PROPERTIES OF NE 111 AND NATON 136 SCINTILLATORS. Bengtson, B.; Moszynski, M. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 75: 152-4(1969).

Measurements of time resolution as function of the triggering fraction C/R for NE 111 and Naton 136 scintillators of different dimensions show that NE 111 is much faster. For ^{60}Co the time resolution is 132 ps. (auth)

4453 DIFFERENT METHODS OF DEAD-TIME CORRECTION IN NUCLEAR PARTICLES COUNTING DISTRIBUTION. Carloni, F.; Corberi, A.; Marseguerra, M.; Porceddu, C. M. (CNEN, Bologna). Nucl. Instrum. Methods; 75: 155-8(1969).

Different methods of dead-time correction are compared. For Poisson distributions the asymptotic method presents a better performance than two matrix-methods. For negative binomial distributions a more general matrix is developed. (auth)

4454 MEAN VALUE AND VARIANCE OF GAS AMPLIFICATION IN PROPORTIONAL COUNTERS. Alkhazov, G. D. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods; 75: 161-2(1969).

A formula for gas amplification in proportional counters is discussed. A formula for gas amplification variance is derived and results of calculations for argon and methane filled proportional counters are presented. (auth)

4455 LOW TEMPERATURE RESPONSE OF SOME SCINTILLATORS. Werkheiser, A. H.; Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods; 75: 167-8(1969).

The relative light output temperature dependence of several scintillators was measured for gamma-ray irradiation. Also, the pulse shape discrimination capability of stilbene was checked for a temperature dependence. (auth)

4456 THIN-WINDOW GERMANIUM DETECTORS: FALLACY AND FACT. Pehl, R. H.; Goulding, F. S.; Hansen, W. L.; Cordi, R. C. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 75: 175-7(1969).

Results demonstrating the successful use of a gold surface-barrier as a thin-window p$^+$ termination of the intrinsic region of a lithium-drifted germanium detector are reviewed. These results are a rebuttal to statements recently made by Dearnaley et al. in this journal. (auth)

4457 STATISTICS OF CARRIER RECOMBINATION AND TRAPPING AND ENERGY RESOLUTION IN SILICON JUNCTION DETECTORS. Deshpande, R. Y. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods; 75: 245-53 (1969).

The problem of recombination and trapping of excess charge carriers in nuclear radiation detectors is discussed. Firstly, a physical model based on these processes is developed to elucidate the limitations on energy resolution. It is suggested that recombination and trapping of charge carriers via recombination centers cause random fluctuation of carrier densities in the free bands and hence energy-line broadening. Corresponding to these processes two sources of noise have been traced viz. generation-recombination noise and trapping-detrapping noise. Then, the details and conditions under which these noises come into play have been worked out specifically for diffused silicon p-n junction detectors. It is shown that with a high-pass filter generation-recombination noise decreases rapidly with decreasing temperature whereas trapping-detrapping noise changes little. After considering these sources of noise charge, collection efficiency is investigated in the presence of preferential carrier trapping. Under these conditions it is shown that charge collection efficiency actually improves when the p-n junction detectors are operated at reduced temperatures. However, preferential trapping can bring in polarization effects and cause injection of spurious charge. Finally, criteria for obtaining trap-free behavior of the detectors are given. It is indicated that a p-n junction diffused detector prepared from 300 ohm · cm p-Si should show trap-free behavior at any temperature. (auth)

4458 NEW METHOD OF ANGULAR CORRELATION MEASUREMENTS. Lewis, R. R. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 75: 203-12(1969).

A new type of angular correlation apparatus is described, and a mathematical model of its statistics is given. The angular correlation of coincident nuclear radiations can be measured by detecting intensity correlations in the output of two counters. For prompt coincidences, the detector currents are mixed in a broadband circuit whose output is the product of the two inputs. The time-averaged output of the mixer is shown to be proportional to the rate of true coincidences, and therefore to the angular correlation function. Furthermore, the fluctuation of this output has the same ratio to the average current as the rate of random to true coincidences both for weak and strong sources. For delayed coincidences, other circuits give the time spectrum and the frequency spectrum of the perturbed correlation function. Possible applications are mentioned, and the relation to the Brown–Twiss interferometer is clarified. (auth)

4459 THE USE OF GEOMETRY DEFINING DIAPHRAGMS ON NaI CRYSTALS. Davies, K. E.; Doubt, H. A.; Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). Nucl. Instrum. Methods; 75: 213-16(1969).

The use of geometry defining diaphragms on NaI detectors when used in angular correlation measurements is examined. A Monte Carlo method was used to calculate the solid angle correction factors. It is concluded that considerable care must be taken with the use of diaphragms and that geometric solid angle corrections can only be applied when the fraction of radiation penetrating the shielding section of the diaphragm is less than 1%. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 5383.

4460 (AD–691424) MULTIPLE LINEAR REGRESSION ANALYSIS OF SCINTILLATION GAMMA-RAY SPECTRA: AUTOMATIC CANDIDATE SELECTION. Hogan, M. A.; Yamamoto, Sachio; Covell, David F. (Naval Radiological Defense Lab., San Francisco, Calif.). 17 Jan 1969. 28p. (USNRDL-TR–69-62). CFSTI.

Multiple linear regression (MLR) has been shown to be a quantitative and statistically justifiable method for unfolding scintillation gamma-ray pulse-height spectra of radionuclide mixtures. The principal requirements of the method are: (1) that well-calibrated data be used, and (2) that the candidate set of spectra (standard spectra to be used as regression variables) must be complete and exclusive. In the usual application of the MLR method, the user exercises a great deal of subjective (irreproducible) judgement in the selection of a candidate set. Several algorithms have been proposed for automatic candidate selection but are not completely justifiable on the basis of proper statistical procedures. An algorithm is described in which justifiable statistical procedures are used. Correlation coefficients are examined to determine the proper candidate set for a given experimental spectrum. The inclusion or exclusion of candidate spectra are justified on the basis of valid statistical indicators, and an estimate of the goodness of the final fit is provided. The results of unfolding actual experimental spectra by this method are included in the paper. (auth) (USGRDR)

4461 (BNWL–1159, pp 7-30) A TISSUE EQUIVALENT PROPORTIONAL COUNTER FOR MEASURING DOSES DUE TO NEUTRON RADIATION. Endres, G. W. R.; Glass, W. A.; Haverfield, A. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The design and performance of a tissue-equivalent proportional counter for measuring neutron doses in mixed gamma–neutron fields are described. (W.H.K.)

4462 IMPROVED FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Hyakutake, Mikio; Wakuta, Yoshihisa (Kyushu Univ., Fukuoka). Kyushu Daigaku Kogaku Shuho; 42: No. 2, 90-6(Mar 1969). (In Japanese).

An improved fast neutron time-of-flight spectrometer was constructed for the measurement of scattering of neutrons of 14 MeV energy. The time-to-pulse height converter was the start-stop type, allowing a maximum counting rate of 5 × 10^4 cps. The neutron detector was a liquid scintillator NE 213 combined with a photomultiplier XP 1040, of which the anode output worked as the start signal of the TPHC, while the stop signal was the delayed pulse from the α-detector which detected the recoil particles from T(d,n)^{4}He reactions or from D(d,n)^{3}He reactions. Owing to the good linearity of response, the dynamic range was broadened in this system 20 times as much as the previously constructed system. For neutron–gamma ray discrimination, the Alexander-Goulding system was adopted and separation of neutrons with energy above 2.5 MeV was possible. Discrimination characteristics with neutrons from the T(d,n)^{4}He reactions and D(d,n)^{3}He reactions and with gamma rays from ^{60}Co were measured. (NSA of Japan)

4463 SAMPLE CONVEYING CHAIN FOR LIQUID SCINTILLATION SPECTROMETER. (to Beckman Instruments, Inc.). British Patent 1,167,205. 15 Oct 1969. Priority date 11 Apr 1966, United States.

A conveyor chain for a liquid scintillation spectrometer is described including tubular links forming sample holding receptacles, adjacent links positioned such that their circumferences substantially intersect along a vertical line; a vertical hole through adjacent links along the line; and, a pin inserted through the hole to interconnect the links, providing for positive rotational orientation of the links when the chain is in tension. (W.H.K.)

4464 A HIGH EFFICIENCY COARSE 4π FAST NEUTRON SPECTROMETER. Thies, H. H.; Boettcher, K. J. (Univ. of Western Australia, Nedlands). Nucl. Instrum. Methods; 75: 231-4(1969).

It is shown how one can measure with a flat-response multi BF$_3$-counter neutron detection system simultaneously the strength of a neutron source, in coarse steps over its 4π-integrated neutron energy spectrum and the mean energy of the neutrons. The neutron energy scale of the system can be calibrated with monochromatic and polychromatic neutron sources. (auth)

4465 COMPENSATOR FOR SHIFTING OF TIME SPECTRA OBTAINED WITH Ge(Li) DETECTORS FOR ENERGIES BETWEEN 0.4 AND 10 MeV. Grenier, G. (CEA, Villeneuve-Saint-Georges, France); Nierat, G.; Poussier, C.; Pigneret, J.; Samueli, J. J. Nucl. Instrum. Methods; 75: 240-4(1969). (In French).

An electronic circuit which compensates the broadening of the time spectrum obtained with a Ge(Li) detector is described. An example of application to the n-γ discrimination in a time-of-flight experiment is given. (auth)

4466 AUTOMATIC DIRECTIONAL CORRELATION SYSTEM. Meder, M. R. (Georgia State Univ., Atlanta). Nucl. Instrum. Methods; 75: 217-19(1969).

An inexpensive method has been devised to automate a directional correlation system. The prerequisites for the system are a multichannel analyzer with an automatic recycling capability and a slow output such as a teletypewriter and the electronics, timing equipment, amplifiers, etc., used in a manual system. The unique features of the system are that it can be constructed from parts readily available in most labs and that both the coincidence spectra and the singles from the movable detector are stored in the multichannel analyzer obviating the need for expensive printing scalers. (auth)

4467 SPECTROMETRY OF SOLAR AND GALACTIC PROTONS ON BOARD SATELLITE IRIS. Amram, Y (CEN de Saclay, Gif-sur-Yvette, France); Axisa, F.; Engelman, J.; Koch, L.; Schneider, C. Nucl. Instrum. Methods; 75: 181-9(1969). (In French).

An experiment designed for the spectrometry of charged particles on board the European satellite IRIS is described. The polar orbit of this satellite has enabled the experiment to measure, depending on the geomagnetic latitude, either the energy of solar protons, or the spectrum of the protons of the internal Van Allen belt, or even the spectrum of the abundance of galactic nuclei whose charge is smaller than 6. The instrument comprises essentially a telescope of solid state detectors of large area (lithium drifted silicon), an analog-to-digital converter, a scaler for counting the flux of the particles and the interface to the telemetry of the satellite. The correct behavior in flight of the equipment is demonstrated from the comparison of the data collected in orbit and the calibration results on ground. Preliminary results obtained for a solar flare are also reported. (auth)

4468 MEASUREMENT OF PHOTO-ABSORPTION CROSS SECTIONS IN THE ENERGY REGION 10 TO 30 MeV WITH A MAGNETIC COMPTON SPECTROMETER. Bezic, N. (Inst. Josef Stefan, Ljubljana, Yugoslavia); Brinsek, A.; Kernel, G.; Snajder, J.; Jamnik, D. Nucl. Instrum. Methods; 75: 190-6(1969).

A method for measuring the total absorption cross sections for photons in the energy region of 10 to 30 MeV is described. Attenuated and unattenuated bremsstrahlung gamma rays from a 33 MeV betatron were analyzed by a 4 channel Compton spectrometer with a 2% resolution. Total photo-absorption cross sections for several light elements were determined. (auth)

4469 SLOW NEUTRON TIME-OF-FLIGHT SPECTROMETRY WITH A PSEUDO-RANDOM INPUT SIGNAL. Virjo, A. (Technical Univ. of Helsinki, Otaniemi, Finland). Nucl. Instrum. Methods; 75: 77-84(1969).

A pseudorandom measurement in time-of-flight spectrometry is a measurement, where the input beam intensity is modulated in a pseudorandom way. Traditionally, the time-of-flight spectrum h(t) is in such a measurement formed by taking the cross-correlation between the modulating signal and the detector output. It is demonstrated that it is also possible to use a Fourier approach, where both the modulating signal and the detector output are Fourier analyzed. Because the pseudorandom signal is composed of discrete, equispaced frequency lines, one can in this way get the Fourier transform H(f) in the corresponding frequency points, and then form h(t) by Fourier synthesis. This method leads to more complex calculations, but on the other hand it offers greater flexibility in the choice of the synthesis procedure, and it is also conceptually simpler. (auth)

4470 GAS RECOIL FAST NEUTRON SPECTROMETER. Mizuho, M. (Japan Atomic Energy Research Inst., Tokyo). Nucl. Instrum. Methods; 75: 85-92(1969).

A gas recoil fast neutron spectrometer of thick radiator type was constructed and its performance investigated. The spectrometer was composed of three methane-filled proportional counters arranged longitudinally with one common center wire. An insulator disk with many holes was inserted between counters A and B as a proton collimator. Signals from the cathodes of counters A and B were used as coincidence signals, while signals from counter C were used as anticoincidence signals. Center wire signals give the neutron spectrum to be measured. No summing circuit was required, because the center wire produces sum signals of counters A and B directly. Energy resolution is estimated by the collimator opening and higher resolution is obtainable by the sacrifice of efficiency. The collimator with 2 mm dia holes was prepared corresponding to 10% resolution. The spectrometer is expected to have a high efficiency because it has many collimator holes (800 to 1000) and one collimating hole forms one counter telescope of the ordinary case. Higher transparency of the collimator also means higher counter efficiency. The collimator has 38% transparency. Efficiency and pulse height distribution of the spectrometer were studied experimentally and theoretically. (auth)

4471 A SINGLE CRYSTAL Ge(Li) CONVERSION-COEFFICIENT SPECTROMETER. Gruhn, C. R.; Todd, R. R.; Maggiore, C. J.; Kelly, W. H. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods; 75: 109-12(1969).

The design and operation of a conversion-coefficient spectrometer in which a single small Ge(Li) crystal serves as the detector both for γ-rays and conversion electrons are discussed. A calibration curve for the detector is presented, and both its advantages and faults as compared with a spectrometer that uses separate detectors for γ-rays and electrons are discussed. (auth)

4472 REDUCTION OF TIME-OF-FLIGHT ERRORS IN PULSED NEUTRON MEASUREMENTS. Meadows, J. W. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 75: 163-4(1969).

Calculations and a measurement show that time-of-flight errors in pulsed neutron experiments can be reduced by using a detector whose efficiency decreases at low neutron energies. (auth)

4473 SENSITIVE SPECTROMETER FOR FAST NEUTRONS USING ^{6}LiI(Eu). Johnson, D. R.; Thorngate, J. H.; Perdue, P. T. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 75: 61-5(1969).

A ^{6}LiI(Eu) scintillation crystal, cooled with liquid nitrogen, was used to measure spectra of low intensities of fast neutrons. There are several complications in reducing the data produced by such a detector. For example, the light produced by the ^{6}Li(n,α)^{3}H reaction used to measure the spectrum and the light from the ^{6}Li(n,n′d)^{4}He reaction that forms the principal interfering reaction are nonlinear functions of the energy deposited in the crystal. These relations were measured and are presented as power functions of the energy. The fast neutron spectrum of an AmBe source and the spectra in air at 571 and 766 m from a source of 14 MeV neutrons are given. Agreement with other measurements and calculations of these spectra is good. (auth)

4474 A SIMPLE METHOD FOR STABILIZING A TIME-OF-FLIGHT NEUTRON SPECTROMETER. Sonoda, M.; Wakuta, Y.; Tawara, H.; Hyakutake, M.; Ijiri, H. (Kyushu Univ., Fukuoka). Nucl. Instrum. Methods; 75: 32-4(1969).

A simple but effective method of digital stabilization of a fast neutron time-of-flight spectrometer is described. Only a commercially available digital stabilizer and an "OR" circuit are added. Two fast outputs of a neutron detector, one being delayed by a definite time and fed to a time-to-pulse height converter through the "OR" circuit, are used as the start and stop signals for reference pulse. The long-term stability is considerably improved. (auth)

4475 ON-LINE COMPUTER CONTROL OF A TRIPLE-AXIS NEUTRON SPECTROMETER. Skaarup, P. (Danish Atomic Energy Commission, Roskilde). Nucl. Instrum. Methods; 75: 1-4(1969).

A description is given of instrumentation for control of a triple-axis neutron spectrometer used in inelastic scattering experiments with single crystals. The instrumentation includes an on-line PDP-8/S computer. Details are given of the principle of operation with the computer. (auth)

4476 LEAST SQUARE FIT PROGRAM. Kuendig, W. (Univ. of California, Los Angeles). Nucl. Instrum. Methods; 75: 336-40(1969).

A versatile computer program written in Fortran IV is described which will least square fit experimental data points that are typically accumulated in measurements using a multichannel analyzer. Convenience in output is a primary factor of the program. Several applications in Moessbauer spectroscopy are presented to illustrate various features of the program. (auth)

4477 CONVERSION FROM DIFFERENTIAL COUNT RATE TO DIFFERENTIAL NUCLEAR CROSS SECTIONS FOR NON-

PARALLEL TARGET–DETECTOR CONFIGURATIONS USING MONTE CARLO TECHNIQUES. Seeser, J. W.; Hurst, R. R.; Schupp, G. (Univ. of Missouri, Columbia). Nucl. Instrum. Methods; 75: 137-40(1969).

A Monte Carlo method for generating charged-particle spectra in Si(Li) detectors is presented. Application of these spectra to resolving complex spectra that have been complicated by thick targets, kinematical considerations, and other experimental problems is discussed. An example is shown of the technique applied to resolving the triton and alpha components in a ^{7}Li(γ,t)^{4}He reaction spectrum involving several discrete energies for the gamma rays incident on a ^{7}LiF target. (auth)

4478 LASER METHOD FOR ABSOLUTE VELOCITY CALIBRATION OF MOESSBAUER SPECTROMETERS. Biscar, J. P.; Kuendig, W.; Boemmel, H.; Hargrove, R. S. (Univ. of California, Los Angeles). Nucl. Instrum. Methods; 75: 165-6 (1969).

The velocity of a Moessbauer drive is converted into a beat frequency of Doppler shifted lines of a laser beam. The counting of this frequency allows a precise velocity calibration. (auth)

4479 PULSE RISETIME DISCRIMINATION FOR ^{3}He COUNTERS. Cuttler, J. M.; Greenberger, S.; Shalev, S. (Technion–Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods; 75: 309-11(1969).

Risetime discrimination is discussed from the point of view of optimizing the experimental conditions of a ^{3}He gas counter for fast neutron spectroscopy. The approach is to transform the pulse risetime into a crossover time (which is easily transformed to an amplitude and stored in a multichannel analyzer), using a double RC differentiating circuit and a crossover pickoff. It was required to maximize accuracy and sensitivity. The behavior of the pertinent factors (attenuation, slope at crossover, sensitivity) was determined as a function of the differentiating time constants T_1 and T_2, and the pulse risetime constant τ. The relationships $T_1 \geqq 2\tau$ and $T_2 \geqq 5\tau$ are shown to represent an optimized system. (auth)

4480 CONSTANT ACCELERATION MOESSBAUER SPECTROMETER WITH VELOCITY RANGE SELECTIVITY. Gaitanis, N.; Kostikas, A.; Simopoulos, A. (Nuclear Research Center Democritus, Athens). Nucl. Instrum. Methods; 75: 274-6(1969).

A constant acceleration spectrometer is described working in any predetermined velocity range of a Moessbauer spectrum. This results in improved resolution with a given number of channels without loss of statistics. The stability of the system is approximately 0.5%, and the linearity is better than 1%. The selective ability of the system is demonstrated in a spectrum of gallium substituted ferrite. (auth)

High Energy Physics Instrumentation

4481 IONIZING-PARTICLE-INDUCED BREAKDOWN IN LIQUID ARGON. Riegler, A. (CERN, Geneva). J. Phys., D (London), 2: 1423-9(Oct. 1969).

In experiments using liquid argon as a spark-chamber medium, a higher probability of breakdown was found in the area of the gap where an ionizing particle had penetrated. For very short high-voltage pulses, a slight diminution of the dielectric strength of liquid argon was observed if the voltage was applied shortly after the passage of an ionizing particle. The observations, although only little above background, indicate that impact ionization should be of importance for the initiation of the breakdown process in liquid argon. (auth) (UK)

4482 FILM-FREE SPARK CHAMBERS IN EXPERIMENTS USING ELECTRONIC COMPUTERS. Golutvin, I. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 497-515 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Design, performance, and operation of film-free spark chambers of magnetostriction and ferrite type are described. Their efficiency, the rate and methods for data retrieval are discussed in detail. (R.V.J.)

4483 MATHEMATICS AND DATA PROCESSING IN CHAMBER EXPERIMENTS. Boeck, R. K. (CERN, Geneva). pp 533-50 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967.

See CONF-671087.

Some basic principles of the analysis programs for track chambers are considered, and some methods are reviewed which have extensive applications for track chamber experiments. Statistical variables, errors, and distributions, error propagation, the principle of least squares or minimum chi square, least squares with parameters, the most general formulation of the least squares program and errors on fitted parameters are reviewed. Also reviewed are chi-square testing, the bubble chamber program at CERN, the data processing aspect, and SLICE and SUMX. (J.F.P.)

4484 HIGH-ENERGY CHERENKOV COUNTERS. Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 551-66 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The design, construction and performance of high-energy and ultra-high energy Cherenkov counters are described. The light-collecting system, the selection of Cherenkov counter luminescence substance, photoelectron multiplier and its operation, dispersion compensation, threshold counters and perspectives and means of Cherenkov–Vavilov effect applications are discussed in detail. (R.V.J.)

4485 TIME-OF-FLIGHT METHOD IN HIGH-ENERGY PHYSICS. Petrukhin, V. I.; Rykalin, V. I.; Khazins, D. M.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 567-86 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The design and operation of a time-of-flight scintillation spectrometer is described. The block-scheme of the system for measuring the time-of-flight on the scintillation counter with the compensation for the scintillator dimension effects on the resolving time is given. The design for the compensation of amplitude straggling, the block-scheme for measuring time intervals during differentiation and double differentiation, the coincidence scheme, the diagram of the shaper with controlling response threshold, the position of the gravity center measured during the time-of-flight with stabilizing and stabilizer-free system during the exposition is given in graphical form and is discussed in detail. (R.V.J.)

4486 ELECTRONIC SYSTEMS FOR HIGH-ENERGY PHYSICS EXPERIMENTS. Zinov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 587-604 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

A brief review is given on the aspects and applications of electronic instrumentation in high-energy physics. The theoretical basis for various devices was analyzed considering two-groups of electron devices: the primary schemes (nanosecond logic blocks), and secondary schemes (the computerization, storage, and processing of experimental data). A brief review is given of computer applications in high-energy physics experiments. (R.V.J.)

4487 NEW CONCEPTS IN BUBBLE CHAMBER TECHNOLOGY. Solov'ev, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 605-36 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Descriptions are given of the aspects, design and performance of various typical bubble chambers used at the present time. Comparisons made of the performance of the existing chambers with the large dimension chambers and chambers with high magnetic fields are tabulated as well as the parameters of some large chambers. (R.V.J.)

4488 THE CONDITIONS OF REGISTRATION OF PARTICLE TRACKS IN A STREAMER CHAMBER. Davidenko, V.; Dolgoshein, B.; Somov, S. (Moscow Physical Engineering Inst.). Nucl. Instrum. Methods; 75: 277-86(1969).

Characteristics of particle tracks in the streamer chamber under different working conditions were studied. The optimal conditions of recording the particle tracks and the measurements of their ionizing ability were formulated. (auth)

4489 PULSE TRANSFORMER FOR LARGE WIRE SPARK CHAMBERS. Andersson, L.; Radermacher, E.; Rubbia, C. (CERN, Geneva). Nucl. Instrum. Methods; 75: 341-3(1969).

It is remarked that by interposing a stepdown transformer between the high-voltage generator and wire spark chambers, the pulsing of the larger size chambers can be eased considerably. A simple transformer made solely of coaxial cables has been built and tested. (auth)

4490 PIEZOELECTRIC MICROPHONES FOR SONIC SPARK CHAMBERS. Bluem, P.; Brinckmann, P. (Univ., Bonn). Nucl. Instrum. Methods; 75: 335(1969).

Microphones for sonic spark chambers using piezoelectric ceramic are described. High sensitivity, reliability and absence of directional sensitivity are the main advantages of this microphone type. (auth)

4491 ANALYSIS OF A SPARK-CHAMBER EXPERIMENT IN A VERY INHOMOGENEOUS MAGNETIC FIELD. Phillips, P. R. (Washington Univ., St. Louis). Nucl. Instrum. Methods; 75: 71-3(1969).

A method is described for achieving a least-squared fit of a track to sparks in a nonuniform magnetic field. The main innovations are in the form of the differential equations used to get the derivatives needed in the fit, and the method of obtaining the magnetic field. Also, a straightforward way of including the effects of multiple scattering is described. (auth)

4492 MULTIPLE FRAME ADVANCE CAMERA CONTROL. Williams, W. A. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 75: 169-70(1969).

This circuit uses an IC decade unit to count the number of film frame advances. At the designated number, it will stop the camera advancement. The system was designed to control the cameras on the 30-inch hydrogen bubble chamber at ANL. (auth)

4493 ON THE DESIGN OF NaI(Tl) TOTAL ABSORPTION DETECTORS FOR STRONGLY INTERACTING PARTICLES AT GeV ENERGIES. Hughes, E. B.; Hofstadter, R.; Lakin, W. L.; Sick, I. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 75: 130-6(1969).

The properties of a large NaI(Tl) detector as a total absorption detector for pions at GeV energies are reported. These observations are supplemented by measurements on the three-dimensional distribution of deposited energy in a large absorber of metallic tin by 8 GeV pions. The latter data are compared with existing Monte Carlo calculations of the nucleon-meson cascade and their application to the design of total absorption detectors with large containment factors is discussed. (auth)

Radiation Dosimeters

4494 (AERE-M-2180) PROGRAMMED TEMPERATURE CONTROL FOR A THERMOLUMINESCENCE DOSEMETER READER TRAY. Rae, J. B. (Atomic Energy Research Establishment, Harwell (England)). Oct 1969. 7p. Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

A programmable temperature controller is described for a low heat capacity stainless steel tray used in thermoluminescent dosimetry. The control range is from ambient to 400°C with an accuracy of ±1°C, and a maximum heating rate of 40°C per second. (auth)

4495 (BNWL-1159, pp 35-49) NEUTRON DOSIMETRY WITH ACTIVATION FILTERS AND TLD. Kocher, L. F.; Endres, G. W. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The design and operation of a multifilter activation rhodium-thermoluminescent combination detector system for personnel neutron dosimetry are described. (W.H.K.)

4496 (BNWL-1159, pp 49-65) THE RESPONSE OF SELECTED THERMOLUMINESCENT MATERIALS TO FAST NEUTRON EXPOSURES. Endres, G. W. R.; Kocher, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The response of thermoluminescent dosimeters including TLD-100, TLD-200, TLD-600, TLD-700, and manganese-doped lithium tetraborate was measured as a function of incident neutron energy and shielding material, using cadmium and boron-10 shields. Fast neutron exposures were conducted with a 2-MeV positive ion Van de Graaff accelerator source of monoenergetic neutrons from 0.2 to 1.0 MeV. (W.H.K.)

4497 (UCRL-Trans-10399) SENSITIVE GAMMA BEAM CALORIMETER. Handl, J.; Kovar, Z. Translated by A. Berger for Univ. of California, Lawrence Radiation Lab., Livermore, from Jad. Energ.; 14: 110-12(1968). 10p. Dep. CFSTI.

The design and results of calibration of a thermistor semi-adiabatic calorimeter with one absorber, designed for standardization measurements of ^{60}Co gamma ray beams, are presented. The sensitivity, 3.17×10^{-2} deg/J, makes it possible to measure ^{60}Co gamma beam powers from 0.1 mW with an accuracy of 2%. (auth)

4498 THERMOLUMINESCENT RESPONSE OF CaF_2:Mn MIXED WITH ORGANIC LIQUIDS IN THERMAL AND FAST NEUTRON FIELDS. Puite, K. J. (EURATOM-ITAL, Wageningen, Netherlands). Health Phys.; 17: 661-7(Dec 1969).

The thermoluminescent response of CaF_2 : Mn mixed with mixtures of acetone-acetonitrile and alcohol-boric acid during a thermal neutron irradiation has been determined. The following nuclear reactions occurring in these liquids have been utilized, $^{14}N(n,p)^{14}C$ and $^{10}B(n,\alpha)^{7}Li$. Also the response of CaF_2: Mn mixed with alcohol has been determined in a fast neutron field. This response is mainly due to the proton recoil reaction. The efficiency for the production of thermoluminescence from the protons and carbon recoils, alpha and lithium recoils and from the proton recoils, produced in the surrounding liquids, was 5, 3 and 11%, respectively, compared to that of gamma rays. The gamma ray induced thermoluminescence is based on the absorbed dose in muscle tissue. In a mixed field of thermal or fast neutrons and gamma rays the sensitivity of dry CaF_2 : Mn to gamma rays and neutrons was found to be 65% of that in a pure gamma field and this restricts the use of CaF_2 mixed with liquids as a neutron dosimetry system. (UK)

4499 SILVER-ACTIVATED PHOSPHATE GLASS. (to Ernst Leitz GmbH). British Patent 1,169,312. 5 Nov 1969. Priority date 9 Feb 1967, Germany.

A silver-activated phosphate glass for use as a dosimeter glass is presented which is made from a frit mixture consisting of 75-90% by weight of lithium metaphosphate and aluminum metaphosphate, the proportion of the former to the latter being in the inclusive range of 17.7/22.3 to 23.3/14.2; 2-8% by weight of silver metaphosphate; 7-20% by weight of beryllium oxide; 90 and up to 2% by weight of sodium nitrite. (W.H.K.)

4500 DESIGN AND APPLICATION OF AN ADIABATIC CALORIMETER FOR MEASURING THE DOSE RATE IN A REACTOR. Stolte, S. (Institut fuer Reaktorphysik, Geesthacht, Ger.). Atomkernenergie, 14: 417-22(Nov.-Dec. 1969). (In German).

Construction and application of an adiabatic calorimeter are described containing three test specimens consisting of AlMg3, Zr, and $ZrH_{1.42}$. Due to different interaction effects of the radiation components it is possible to relate the measurements to the radiation components. Thermal shields of the same (or nearly the same) material as the specimens serve to maintain adiabatic conditions during the measurement. From these calorimetric measurements the percentages of the different radiation components are found for the materials Al, Zr, $ZrH_{1.42}$, Mg, and H. (auth)

Radiometric Instruments

Refer also to abstract 4408.

4501 RADIOLOGY AND THERMOGRAPHY APPLICATIONS TO RELIABILITY. Dodement, G. (Compagnie Generale de Radiologie, Issy-les-Moulineaux, France). pp 651-61 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4-6 November 1968. Paris; OPHRYS (1968). (In French).

See CONF-681118.

Recent improvements in the domain of x-rays associated with x-ray sensitive vidicons, high gain luminance amplifiers, and highly definite television chains make it possible to detect and observe the internal structure of electronic components (transistors, integrated circuits, etc.), without any destructive effect. Also, developments under way make it possible to analyze printed circuits while operating and to detect casual defects on constitutive elements (i.e., short circuited transistor, cut circuits, null or too-high intensities through resistors) and any power characteristic that is not in accordance with standards. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 4206, 4209, 4394, 4501, and 4798.

4502 (BNWL-1134) DEVELOPMENT OF AN INFRARED HYGROMETER. Reich, F. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 51p. Dep. CFSTI.

Infrared techniques and instrumentation show promise for measuring gas coolant impurities within high temperature nuclear reactors. An experimental hygrometer using an infrared absorption null instrumentation technique responded smoothly over water vapor contents at STP from 20 to 10,000 ppM. An instrument accuracy greater than 80% was obtained from calibration data obtained with a helium gas carrier and a water content controlled with a variable pressure saturator. A digital computer analog of the infrared hygrometer helped in gaining insight of the absorption null instrumentation and in optimizing sensitivity. The response and sensitivity of various infrared filter components could be examined before the tedious and expensive fabrication process was initiated. The computer analog also indicated instrument response for the infrared detection of other impurity gases and liquids for absorption null instrumentation. (auth)

4503 (CEA-R-3897) MASMA: A VERSATILE MULTIFUNCTIONAL UNIT (GATED WINDOW AMPLIFIER, ANALOG MEMORY, AND HEIGHT-TO-TIME CONVERTER). Goursky, Vsevolod; Thenes, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1969. 45p. (In French). Dep. CFSTI (U. S. Sales Only).

This multipurpose unit is designed to function as gated window amplifier, analog memory, or a height-to-time converter. The first function is mainly devoted to improve the poor resolution of pulse-height analyzers with a small number of channels. The analog memory, a new function in the standard range of plug-in modules, is capable of performing a number of operations including fixed delay, or variable delay dependent on an external parameter (application to the analog processing of non-coincident pulses); derandomizer to increase the efficiency of the pulse-height analysis in a spectrometry experiment; and linear multiplexer to allow an analyzer to serve as many spectrometry devices as memory elements that it possesses. Associated with a coding scaler, this unit, if used as a height-to-time converter, constitutes a WILKINSON A.D.C. with a capability of 10 bits (or more) and with a 100 MHz clock frequency. (auth)

4504 (GEMP-712) 1000 HOUR-2300°C THERMOCOUPLE TEST NO. 2. Baxter, W.; Kuhlman, W. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Oct. 1969. Contract AT(40-1)-2847. 9p. Dep. CFSTI.

Two thermocouples have successfully completed an 1100 hour exposure at 2300°C with essentially zero decalibration. The thermocouples were constructed of 0.009″ W-3Re versus W-25Re, insulated with high purity two hole thoria insulators, and contained within a W-25Re sheath. Both couples were slowly and rapidly thermocycled during the test period. (auth)

4505 (IPP-3/89) CONSTRUCTION OF A MACH-ZEHNDER INTERFEROMETER FROM NONMAGNETIC MATERIAL. Klingenberg, H.; Zickert, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1969. 32p. (In German). (IPP-4/66). Dep. CFSTI (U. S. Sales Only).

The Mach-Zehnder interferometer is an important diagnostic tool in plasma physics. Many experiments in plasma physics call for high magnetic fields that can be produced with large electromagnets for short times, e.g., 1 sec. Commercially available interferometers made of ordinary steel are often unsuitable because the magnetic attraction is too strong. A Mach-Zehnder interferometer with non-magnetic components was therefore built (permeability $\lesssim 1.05$), in the 45° version on the single-mirror principle. The clear arm spacing is approx. 1 m, the vertical clearance from the center line of the upper mirror to the framework approx. 0.5 m. The total length is approx. 2 m, the height approx. 1.3 m, the weight approx. 1500 kp. The instrument is mounted on shock absorbers. Precision motion, viz. inclination of the mirrors and linear motion of a mirror, is possible down to 1×10^{-4} mm. The field of view, i. e. the common cross section of the collimated beams, is greater than $(70 \times 90)\ \mathrm{mm}^2$. The second pair of collimated beams is also utilized, e.g. for simultaneous measurements at two different wavelengths. A deflection mirror for the second pair facilitates handling. (auth)

4506 (JUL-595-RB) INDUCTIVE FLOWMETER AS PICK-UP FOR DETERMINATION OF THE PARAMETER IN A TWO PHASE STREAM. Jonas, Heinz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). May 1969. 18p. (In German). Dep. CFSTI (U. S. Sales Only).

The practicability of an inductive flowmeter as a pickup for the determination of the parameter of a two-phase system was investigated. Its use for the measurement of the velocity and size of bubbles and the changes occurring in the flowmeter as a result of the stream pattern were investigated. The results showed that the velocity and bubble size could be determined with high accuracy. The profile of deformed bubbles can be determined under certain conditions with the length and the mean diameter. The asymmetry effect is not of decisive importance. (tr-auth)

4507 (NP-18077) A FEEDBACK REGULATED ELECTRON SOURCE. Note No. 230. Cantarano, S.; Egidi, A. (Rome Univ. (Italy). Istituto di Fisica). 10 Jul 1969. 9p. Dep. CFSTI (U. S. Sales Only).

The design of a simple electron source for testing and calibrating instruments on-board satellites for studying interplanetary plasma is described. The source consists of a cylindrical stainless steel body containing a tungsten filament heated by a power supply controlled by a feedback loop. A Faraday cup and electrometer monitors the beam current and controls the filament current input. (W.H.K.)

4508 (PB-185047) COAXIAL CABLES OF LARGE RADIUS: A STUDY OF RESPONSE FUNCTIONS WITH CERTAIN ADVERSE TRAITS. Franklin, Constance W. (EG and G, Inc., Bedford, Mass. Eastern Science and Technology Div.). 15 Apr 1964. 49p. (EGG-B-2722; EGG-1183-511). CFSTI.

Cables of large diameter cannot be expected to have altogether the simple complementary error-function unit-step response attributed to those of lesser diameter. This is a study of three pieces of large cable to ascertain the precise way in which their response differs from that predicted by small diameter theory. Its conclusion is that with increasing diameter there is increasing deterioration and delay of rise front and later an oscillatory behavior that increases its amplitude with increasing diameter. The precise frequencies of these oscillations are somewhat unexpected. Since, in general, such cables must always both be used and tested in conjunction with apparatus whose leads are of different diameter, they have necessarily been observed with transitions in this study. The response functions which appear at the end of the text, therefore, represent the particular pieces of cable with their transitions. Further repetition and a more subtle experiment is implied if it is desired to give the present formulations greater generality. Comparative evaluation of the effectiveness of these cables for specific purposes is already possible in terms of the inputs with which it is desired to use them. (auth) (USGRDR)

4509 (UCRL-71780) TIME-SHARING A DISK MEMORY FOR ON-LINE SPECTRUM ACCUMULATION FROM MANY NUCLEAR PULSE-HEIGHT ANALYZERS. Uber, Donald C. (California Univ., Livermore. Lawrence Radiation Lab.). 4 Nov 1969. 13p. (CONF-691017-5). Dep. CFSTI.

From 16th Nuclear Science Symposium, San Francisco, Calif.

Several pulse-height analyzers time-share a large disk memory for on-line accumulation of sorted spectra. The system is controlled by a PDP-8 computer which performs a two-level hardware-software sort on the data in real time. The computer dynamically allocates storage to incoming events and schedules disk accesses to achieve high sorting rates under a variety of counting loads. (auth)

4510 (Y-1698) INVESTIGATION OF ULTRASONIC DATA ANALYSIS USING A MULTICHANNEL ANALYZER OR EQUIVALENT CIRCUITRY. Elkins, J. D.; Sachs, R. D.; Austin, L. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 10 Dec 1969. Contract W-7405-eng-26. 15p. Dep. CFSTI.

A study of simulated weldment flaws by a multichannel pulse height analyzer showed that the flaws assume separate characteristic locations among the 400 memory channels of the analyzer. A digital computer may be used in conjunction with the analyzer to completely process the ultrasonic information. (auth)

4511 NUCLEAR INSTRUMENTATION IN HALDEN. Firing, Joergen A. (Institutt for Atomenergi, Halden, Norway). Elektrotek. Tidsskr.: 82: 332-7(28 Aug 1969). (In Norwegian).

At the OECD Halden Reactor Project extensive in-core sensing and read-out systems have been developed. The in-core instruments monitor critical fuel and channel parameters and permit fuel assemblies to be operated with relative safety at frontier conditions. The instruments comprise turbine flow meters, flux detectors to indicate channel powers, coolant and fuel thermocouples, fission gas pressure transducers, and void elongation detectors. (auth) (Norway)

4512 HELICAL DETECTOR AND ALARM SYSTEM FOR 2450MHz AND APPLICATIONS. Griffiths, V. S. (Univ. of Surrey, Guildford, Eng.); Allam, D. S.; Fletcher, K. Non-Ioniz. Radiat.: 1: 66-9(Sep 1969).

The design of a broad-band, wide-angle aerial based on the original data devised by Kraus for a helical beam radiator is assessed, and a method for providing a system checking facility giving an automatic alarm is described. Leakage patterns radiating from ovens designed for use in the catering industry were measured and these were found to be related to the mechanical design of the doors and time interval of the interlock mechanism. A 30 kW newspaper printing installation was also examined, and the implications of the growing use of microwave heating in industry is discussed. (auth) (UK)

4513 THIN-FILM SPHERICAL BOLOMETER FOR MEASUREMENT OF HAZARDOUS FIELD INTENSITIES FROM 400 MHz TO 40GHz. Fletcher, K.; Woods, D. (Univ. of Surrey, Guildford, Eng.). Non-Ioniz. Radiat.; 1: 57-65(Sep 1969).

A bolometer is described for monitoring intense rf radiation, primarily for health safety. The generally accepted maximum level of intensity that is considered to be safe for the health hazard is 10 mW cm^{-2} from 30 MHz to 30 GHz. The spherical bolometer was developed to overcome the limitation of frequency dependence and the need to point the aerial in the plane of polarization found in current monitors. The instrument sums the total power flux density of any number of radiations of arbitrary polarization and direction of propagation in the frequency range 400 MHz and 40 GHz. Such omnidirectional devices have been employed in the past, but were frequency sensitive and possessed unacceptably long time constants for field use. (auth) (UK)

4514 THE PERSONAL CENTRIPETER: A PARTICLE SIZE-SELECTIVE PERSONAL AIR SAMPLER. Langmead, W. A.; O'Connor, D. T. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Ann. Occup. Hyg.; 12: 185-95(Oct 1969).

A size-selective air sampler suitable for the measurement of personal exposure to radioactive dust is described. Sampling at 2 l/min, it separates coarse dust from the finer particles which are collected separately on discs of high efficiency glass fibre filter paper suitable for direct radiation counting. Suction is provided by a diaphragm pump, the rapid variation of air flow-rate being suppressed by a pulsation damper. The collection characteristic of the first stage (the cone) is such that 50 per cent of the mass associated with unit density spherical particles of diameter above 5 μm is collected; the remainder is deposited on a filter paper in the second stage. Wall losses as a function of particle size were measured. The maximum loss (~14 per cent) occurs on the nozzle of the cone for particles of diameter about 3 μm. (auth) (UK)

4515 A DIGITAL DATA ACQUISITION SYSTEM FOR USE IN NUCLEAR MEDICINE SCANNING AND WHOLE BODY COUNTING. Cook, William Elbert Jr. Nashville; Vanderbilt Univ. (1969). 140p.

A digital data acquisition, display, and analysis system has been designed and constructed and is currently in use in the areas of isotope scanning and whole body counting at Vanderbilt University Hospital. The system collects, in core memory, data representing the spatial distribution or energies of radioisotopes in the human body. This data is displayed on a cathode ray tube. The data is transferred from core memory to magnetic tape for storage and to allow computer analysis of the data. This analysis includes 1) corrections for data collection inaccuracies 2) filtering of data 3) generation of contours and spatial gradients 4) comparison of simultaneously collected distributions from two isotopes, and 5) time rates of change of the distributions of one or more isotopes. A research scanner which doubles as a whole body counter was constructed in a low radiation background steel room. Detailed descriptions are given of the digital methods used for positional information and motion control of this scanner. The control logic for scanner motion, the core memory to magnetic tape interface, and the scanner to memory interface were implemented using digital integrated circuits. Logic functions constructed from these integrated circuits and logic level conversion circuits were placed on printed circuit cards whose terminals appear on a patchboard receiver. This allows one to use the logic system for multiple jobs by changing patchboards. The elimination of reliability problems is discussed. Attention is given not only to the design and construction details of this system, but also to the evaluation of its use as a research and clinical facility. Clinical examples are used to illustrate the relative advantages of various instrument configurations and of computer data analysis. (Diss. Abstr.)

4516 IMPROVEMENTS IN DEVICES FOR MEASURING MAGNETIC FIELD GRADIENTS. Salvi, Antoine; Roback, Francis; Raffini, Paul. (to Commissariat a l'Energie Atomique). British Patent 1,167,961. Oct. 22, 1969. Priority date Feb. 4, 1966, France.

The design and operation of an NMR gradiometer for measurement of magnetic field gradients are described. The instrument is designed for measuring the variations of the earth's magnetic field intensity for prospecting purposes. (W.H.K.)

4517 TRANSMISSION LINE TRANSFORMERS FOR GROUND LOOP NOISE SUPPRESSION. Fullwood, R. R. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 75: 349-50 (1969).

The use of transmission line transformers for the suppression of ground loop induced noise is investigated. In the experiment described, a noise reduction of 100 was achieved. (auth)

4518 INEXPENSIVE GAIN STABILIZER CONTROLLED BY A TIME-SHARED COMPUTER. Robinson, L. B.; Goulding, F. S. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 75: 117-20(1969).

An electronic pulse amplifier is described for automatic gain correction in high-resolution high-rate pulse-height analysis systems. The circuit gain is controlled by a PDP-7 computer devoting less than 4 ms per second of its time to provide gain correction signals for up to 8 amplifiers. Necessary control voltages are developed in the computer's CRT display circuits and transferred to a "sample and hold" circuit associated with each gain stabilizer. Gain control is accomplished by adjusting the gate voltage of an FET which shunts a small fraction of the total signal. (auth)

4519 ANALOG STORE AND MULTIPLEXER FOR PULSE-HEIGHT ANALYSIS. Robinson, L. B.; Gin, F.; Cingolani, H. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 75: 121-4(1969).

An electronic analog pulse storage unit is described. Used in conjunction with on-line computers, the unit allows high-resolution pulse-height analysis of eight-parameter coincidence events by use of a single ADC. (auth)

4520 TIME DERANDOMIZER FOR ANALOG PULSES. Robinson, L. B.; Gin, F. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 75: 125-9(1969).

A storage unit for analog pulses is described which is used to decrease counting losses in high-rate, high-resolution, pulse-height analysis experiments. Three pulse stretchers connected in series store up to three pulses until they can be processed by an external analog-to-digital converter. An effective dead time of 6 μs is achieved when analyzing randomly occurring pulses at rates up to 20,000 cps. No degradation in pulse height resolution due to the insertion of this instrument has been detected. (auth)

4521 EMITTANCE MEASUREMENT OF THE MAGNETRON ION SOURCE. Marsicanin, B. S. (Boris Kidric Inst. of Nuclear Sciences Belgrade). Nucl. Instrum. Methods; 75: 106-8(1969).

The emittance of the magnetron ion source was measured in two perpendicular planes. Using electrostatic deflection, the beam was scanned over two apertures and the corresponding signal displayed on an oscilloscope screen. For an extraction voltage of 15 kV the normalized emittance amounts to about 0.25×10^{-6} Rad · m in both planes, for an argon beam of 300 μA. (auth)

4522 COMPENSATION OF EMITTER-BASE VOLTAGE VARIATIONS WITH OPERATIONAL AMPLIFIERS. Harms, J. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 75: 173-4(1969).

Low cost operational amplifiers can replace temperature compensating devices and trimmer potentiometers in direct-coupled pulse amplifiers and discriminators. Better temperature and long term stability without adjustments can be achieved with this technique than with conventional means. (auth)

4523 USE OF THE LIGHT PEN IN PULSE ANALYSERS. Chorzewski, J. W.; Sikora, B. R.; Wesolowski, E. A. (Univ. of Warsaw). Nucl. Instrum. Methods; 75: 235-9(1969).

A simple electronic system with a light pen connected with the pulse height analyzer has been set up. This system performs a number of functions: it inscribes an arbitrarily chosen number into the selected channel, clears the contents of any chosen channel, determines the number and contents of the channel indicated by the light pen, integrates the spectrum in the range indicated, and allows a precise one-dimensional analysis of events from selected regions in a two-parameter space. (auth)

4524 INEXPENSIVE PULSE HEIGHT DIGITISER CIRCUIT. Calligaris, F.; Cernigoi, C. (Univ., Trieste, Italy). Nucl. Instrum. Methods; 75: 325-7(1969).

The circuit described gives an output consisting of a number of pulses proportional to the height of the input pulse, within a large range of its shape. (auth)

4525 CHILD-LANGMUIR LAW IN THE RELATIVISTIC REGIME. Yadavalli, S. V.; Bollen, R. L. (Stanford Research Inst., Menlo Park, Calif.). Nucl. Instrum. Methods; 75: 229-30 (1969).

An exact numerical solution describing the Child–Langmuir law appropriate to the relativistic regime is obtained for the case of a parallel plane diode. The numerical solution is carried out for anode voltages up to about one hundred million volts. Also, some comments are made regarding the Child– Langmuir law applicable to other geometries. (auth)

4526 INTEGRATED-CIRCUIT DISCRIMINATOR WITH 10-nsec PULSE PAIR RESOLUTION. Barna, A.; Cisneros, E. L. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 75: 261-5 (1969).

A high-speed direct-coupled discriminator utilizing emitter-coupled integrated circuits is described. The threshold is continuously adjustable between −150 mV and −1.15 V, the pulse pair resolution is 10 nsec, and the maximum continuous repetition rate is 92 MHz. Two modes of operation, clipped and dc, are provided; output widths in the clipped mode are 5 nsec, 10 nsec, or 15 nsec. The use of integrated circuits results in a complete absence of trimming adjustments. Provision is made for remote control of the threshold, mode, and width. (auth)

4527 INTERNATIONAL CONFERENCE ON RELIABILITY OF ELECTRONIC COMPONENTS FOR SPACE, GRENOBLE, [FRANCE], 4–6 NOVEMBER 1968. Paris; OPHRYS (1968). 685p. (In French and English). (CONF-681118).

Separate abstracts were prepared for 10 of the 35 papers presented. The remaining 25 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 4501 and 4532–4540.

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 4527.

4528 (BNWL–1148) NUCLEAR RADIATION INDUCED CURRENT AND INSULATOR ELECTRICAL CONDUCTIVITY MEASUREMENT TECHNIQUES APPLIED TO COAXIAL CABLES. Stringer, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)–1830. 27p. Dep. CFSTI.

The techniques used in measuring the nuclear radiation induced current and the combined temperature and radiation induced electrical conductivity on metal oxide (MgO) insulated coaxial cables are described. An analysis is presented for each technique described and several problems encountered in applying the techniques are discussed. Data are presented for the induced electrical conductivity as a function of temperature to 750°C and radiation dose rate to 9×10^{10} R/hr. (auth)

4529 (N–69–36187) DEVELOPMENT OF LITHIUM DIFFUSED RADIATION RESISTANT SOLAR CELLS. Quarterly Report. Payne, P. (Heliotek, Sylmar, Calif.). Jan. 15, 1969. Contracts NAS7-100; JPL-952247. 19p. (NASA-CR–105616). CFSTI.

Work on evaporated lithium as a diffusion source continued. Sintering of P/N cells with and without lithium was also studied. Emphasis was placed on those cells without lithium in order to isolate the effect of sintering a TiAg contact on a P/N cell from the effect of heat treatment on lithium diffused cells. The fifth and sixth lots of lithium cells were fabricated. Yield analyses of these cells were made. (auth) (USGRDR)

4530 (N–69–36277) THEORETICAL INVESTIGATION OF RADIATION DAMAGE AND TRANSPORT PROPERTIES OF SOLAR CELLS. Final Status Report, January 1968–August 1969. Tanaka, Tomoyasu (Catholic Univ. of America, Washington, D. C. Dept. of Physics). 7p. (NASA-CR–105598). CFSTI.

Radiation damage in solar cells is investigated from a phenomenological, and a quantum mechanics treatment standpoint. Interference effect on annealing temperature of A-centers and E-centers in silicon are interpreted. The mechanism of creation and annihilation of defects and centers created in semiconductors by irradiation is treated by simplified mathematical models. The first principal calculation of the energy of formation of a defect in metals and semiconductors is discussed. (USGRDR)

4531 (RN-TM–419) TRANSMISSION CABLE TEMPERATURE EFFECTS. NRO Technical Memorandum. Takeda, S. (Aerojet-General Corp., Sacramento, Calif.). 27 Feb 1967. 18p. Dep. CFSTI.

Among the effects of gamma flux on an instrumentation system is the change in transmission cable characteristics which is primarily due to the increase in temperature of the cable. This effect is demonstrated in terms of errors introduced into an instrumentation system by changes in sheathed cable resistance and cable isolation. A general discussion of the problem areas encountered in the various systems is presented. The strain gage (full-bridge), potentiometric RTT (constant current), double bridge RTT, piezoelectric accelerometer using the charge amplifier, and thermocouple systems were investigated. It was assumed that in each system fifteen feet of sheathed cable were exposed to temperatures ranging from 1200 to 1800°R. These temperatures were then translated into changes in line resistance and shunt resistance. Introduction of these values into the various systems indicated that no general problems arose because of temperature except in the case of the strain gage system. (W.H.K.)

4532 SPATIAL STRESSES. Cacheux, J. (Centre National d'Etudes Spatiales, Bretigny, France). pp 175-95 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4–6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

Using systematic launchings of appropriate probes, spatial environment becomes more and more defined for each flight and first experiments ambiguity is disappearing. Quantitative and qualitative definition of the stresses is reviewed under three aspects: (1) stresses relative to the machine or to its vector: mechanical stresses, shocks, accelerations, vibrations, corrosion, low weight, dimensions; (2) normal stresses: climatic, thermal, barometric; and (3) specifically spatial stresses: absence of gravity, vacuum or specific atmosphere, photonic rays, energetic particles, meteorite streams, magnetic field, special stresses. Some stresses, relative to fugitive phenomena, are evolutive. Nevertheless, a list of rules can be defined. Finally, the speculative character of certain stresses is underlined and shows the existence of numerous still-unknown parameters, as well as the non-exhaustive aspect of this paper. (auth)

4533 STUDY OF THE INFLUENCE OF SURFACE PROPERTIES ON PLANAR BIPOLAR TRANSISTOR RELIABILITY. Martinot, H.; Esteve, D.; Rossel, P.; Andre, B. (CNRS, Toulouse). pp 223-49 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4–6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

A study to show how variations of planar bipolar transistor characteristics versus time and under the influence of temperature or ionizing radiations may be related to the variations of the emitter-base junction surface properties is described. It includes the influence of surface properties on bipolar transistor characteristics: Evidence and analytical expression of the various components of a P.N. junction surface recombination current; evolution surface phenomena: "linear" drift and "dissymmetrical" drift of M.O.S. transistor drain-current; and bipolar transistor reliability: I_B and V_{EB} drifts at constant I_C, have been studied for various transistors as a function of time, for several hundreds of hours. These components have been submitted to a series of thermal and electrical stresses which resulted in variations of the drifts, gain-current and noise characteristics. The observed phenomena can be explained from the results. Thus, a certain number of reliability classification rules can be defined. (auth)

4534 COMPARATIVE EFFECTS OF VARIOUS ANNEALING TREATMENTS ON A 2N 2907 PNP TRANSISTOR EXPOSED TO 10^7 RADS OF ^{60}Co GAMMA RAYS. Ghirlanda, J. (Texas Instruments France, Villeneuve-Loubet); Benbadis, H.; Savelli, M. pp 251–71 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4–6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

Measurement of various electrical parameters is used to study physically the behavior of silicon planar transistor homogeneous lots submitted to a 10^7 rads dose of cobalt 60 gamma rays. Recovery of the transistor initial characteristics was performed either by isochronal or isothermal annealing, or under saturated and active operation of the device. Experimental measurements are analyzed statistically on a computer allowing a comparison of each treatment efficiency. A physical interpretation of the annealing under transistor saturation is proposed. (auth)

4535 THERMAL RECOVERY OF DEFECTS GENERATED BY IONIZING RADIATIONS IN SILICA LAYERS. Buxo, J.; Martinez, A. (CNRS, Toulouse). pp 273–81 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4–6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

M.O.S. transistors were irradiated with x rays and low-energy electrons (50 keV) under constant gate-voltage or constant drain-current. Then, the damaged samples were submitted to temperatures ranging from 100°C to 250°C under various electrical bias conditions. A systematic experimental study of these two parameter influences is shown. It appears that the $I_D(V_G)$ transfer characteristics of the component are moving on parallel lines towards more positive gate-voltages; at constant gate bias, this translation reached a saturation value as time increased; and this value depended only on the last voltage applied on the gate. An interpretation of these phenomena is given considering that electrons are injected at the M.O.S. structure electrodes level. (auth)

4536 RADIATION EFFECTS ON MIS STRUCTURES. Grosvalet, M. (Compagnie Generale de Telegraphie San Fil, Puteaux, France). pp 283-94 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4-6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

Radiation effects in metal-dielectric-semiconductor structures exposed to a flux of 10^{13} cm^{-2} electrons at 1 MeV are investigated. Models explaining the mechanism of the effects are discussed. (C.E.S.)

4537 TEST UNDER 1 MeV ELECTRONS OF A LOGIC DESIGNED FOR SPACE APPLICATIONS. Bernard, J.; Rochet, A.; Beausse, J. (CEN, Grenoble, France). pp 295-317 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4-6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

A very low power consumption family logic is tested with 1 MeV electrons to qualify it for space applications. Tests deal with the electronic components that are used and then with some particular circuits of this logic family (inverter, flipflop, supply unit). The behavior of this low power consumption logic is compared with R.T.L. logic in order to identify its advantages with respect to common circuits. Radiation hardness, added to other electrical features, make this logic very interesting for space applications. (auth)

4538 INCIDENCE OF SCREENING ON THE RELIABILITY OF PLANAR TRANSISTORS EXPOSED TO IRRADIATION-RESTORATION CYCLES. Benbadis, H. (Texas Instruments France, Villeneuve-Loubet); Ghirlanda, J.; Blin, A.; Le Ber, J. pp 375-400 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4-6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

Because of the numerous factors influencing irradiated bipolar transistor behavior, a laboratory simulation of the environmental conditions and a statistical study were performed in the view of realizing electronic circuits to be operated in space. Comparison is made between lots of bipolar transistors having sustained a "high reliability" qualification and those for normal use. Then, step stresses allow to appreciate, by comparison to lots taken as references, whether the irradiated devices have become more sensitive. (auth)

4539 RELIABILITY OF PASSIVE COMPONENTS EXPOSED TO IONIZING RADIATIONS. Belloc, P. (Industries Electriques, Fontenay-aux-Roses, France); D'Harcourt, A. pp 437-55 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4-6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

Resistance of passive components exposed to radiations currently appears to be a minor problem as compared to that of active components. Though observed drifts are not noticeable in most of the cases, it appears that this is not a general rule and that the conception of a circuit without taking into account drifts due to radiation effects on passive components may lead to nonnegligible failure probability. Knowledge of the electrical and mechanical properties of the basic materials and of the technelogical processes often allows to foresee the finished products resistance. Some limits for utilization have been defined for the studies components. Finally, it appears that in some instances, stabilization of the components may be obtained by preirradiation. The study was made on various capacitors including ceramic, mica, aluminum-tantalum and mylar-polycarbonate electrochemical; and on various carbon and metal thin film agglomerate resistors. Irradiations were performed with γ rays and electrons. (auth)

4540 C.A.D HELPS IN CHOOSING DEVICES FOR CIRCUIT OPTIMIZATION. Imbrechts, C. (CEN de Saclay, France); Doucet, F.; Le Ber, J.; Backmann, M. pp 621-49 of International Conference on Reliability of Electronic Components for Space, Grenoble, [France], 4-6 November 1968. Paris; OPHRYS (1968). (In French).
See CONF-681118.

When studying electronic materials to be shipped on board a satellite, drifts as a function of the various stresses the material will have to suffer, must be taken into account. Because of circuit complexity and the large number of devices, programs on machines for computing electronic circuits must be used. Advantages presented by these new working methods are reviewed and consecutive exigences concerning parameter definition of the devices are emphasized. As an example, some electronic circuits for an X-ray spectrometry experiment on board a satellite are presented. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstracts 4242, 4618, and 4619.

4541 MICROMETHOD FOR ASSAYING IMMUNE CYTOLYSIS BY THE RELEASE OF ^{51}Cr. Kaliss, Nathan (Jackson Lab., Bar Harbor, Me.). Transplantation, 8: 526-30(Oct. 1969).

A modification is reported of the technique which measures the potency of cytolytic antiserum by the amount of ^{51}Cr released from damaged cells. The method described utilizes small quantities of reagents, a rapid titration procedure, and a well buffered suspending medium for the target cells. The description is based on the use of mouse alloantisera and lymph node target cells. (MMB)

4542 LABELLED ATOMS IN HYGIENE STUDIES. Yudina, T. V.; Nobikov, Yu. V. (Moscow Research Inst. of Hygiene). Gig. Sanit., No. 7, 59-64(July 1969). (In Russian).

Although it has not yet been very much used, the labeled atoms method is well suited for hygienic studies for the determination of very small amounts of materials in the environment, such as the dust content of the atmosphere. Use of β emitters in these measurements makes it possible to determine concentrations as low as 1 mg/m^3 within a short period. The free fluorine content of the atmosphere may be determined on the basis of the $F_2 + {}^2I^- \rightarrow I_2 + 2F^-$ reaction, using columns containing NaI labeled with ^{131}I and sucking air through it. Radiometric titration with ^{65}Zn has been used for determining microamounts of metals. The radioisotope ^{14}C was found useful for the rapid determination of Escherichia coli in water, measuring the activity of the ^{14}C-labeled CO_2 produced by the bacteria. The sensitivity of the method reaches 10^{-7} Ci. The metabolism of the liver of white rats has been studied by means of $^{75}SeO_3$-labeled material which is transformed into the volatile $^{75}Se(CH_3)_2$ released through the lungs. The mineral metabolism has been investigated by an isotopic method based on the absorption of ^{45}Ca in the intestines of animals as a function of the concentration in the drinking water. (TTT)

4543 FUNDAMENTAL STUDY ON MEASUREMENT OF PLASMA INSULIN WITH RADIOIMMUNOASSAY (DOUBLE ANTIBODY METHOD) AND ITS VALUE FOR HEALTHY CHILDREN IN MORNING HUNGER CLASSIFIED BY AGE. Tada, Hiroshi (Tokyo Univ.). Nippon Shonika Gakkai Zasshi, 73: 236-45 (Feb. 1969). (In Japanese).

The measurement of plasma insulin with radioimmunoassay using a double-antibody method was examined, and in 192 cases of morning hunger, plasma insulin value was measured by this technique. The results obtained were as follows: ^{131}I-labelled insulin was prepared by Hunter–Greenwood's method using 5mCi of Na ^{131}I, and insulin with specific activity of 150 to 400 mCi/mg was obtained. Insulin was measured by modified Morgan–Lazarow's double antibody technique. Anti-insulin serum diluted by a ratio of 1 : 80,000 was adequate. Four days for the first step and one day for the second step were required as incubation time to obtain good results. By this technique, insulin value within a range from 2.7 μu/ml to 690.0 μu/ml could be measured, and its mean recovery rate was 101.1%. Measurement of plasma insulin of healthy children in morning hunger classified by age revealed the following values; cord blood 20.5 μu/ml; 0 to 12 month old 12.6 μu/ml; 1 to 5 year old 19.7 μu/ml; 6 to 10 year old 23.5 μu/ml; 11 to 15 year old 36.7 μu/ml; and 16 to 20 year old 30.6 μu/ml. Plasma insulin values tended to increase as children grew older, and the value for 11 to 15 year old children was maximum. Any significant difference of values between male and female was not observed. (NSA of Japan)

4544 RADIOIMMUNOASSAYABLE SERUM LH AND FSH IN GIRLS WITH SEXUAL PRECOCITY, PREMATURE THELARCHE, AND ADRENARCHE. Kenny, Frederic M.; Midgley, A. Rees Jr.; Jaffe, Robert B.; Garces, Ludivina Y.; Vazquez, Angel; Taylor, Floyd H. (Univ. of Pittsburgh. Univ. of Michigan, Ann Arbor). J. Clin. Endocrinol. Metab., 29: 1272-5(Sept. 1969).

The levels of radioimmunoassayable luteinizing hormone (LH) and follicle-stimulating hormone (FSH) in girls afflicted with premature thelarche (PT), premature adrenarche (PA), and idiopathic sexual precocity (ISP) were determined. The mean content of LH for normal subjects was 3.13 ± 1.48 mIU (milli International Units), for PT patients 4.27 ± 2.83, for ISP patients 7.20 ± 4.26, and for PA 2.60 ± 1.48. The mean content of FSH for normal patients was 6.27 ± 2.46, for PT patients 7.21 ± 3.01, for ISP patients 12.48 ± 7.20, and for PA patients 3.44 ± 2.10. For both LH and FSH the hypothesis of identity of distribution of values among the four groups was rejected. The association between circulating levels of LH and FSH and the etiology of the three disorders is discussed. (C.O.)

4545 STUDY ON SERUM ANTIBODIES TO COW'S MILK PROTEINS USING RADIOIMMUNOELECTROPHORESIS AND RADIOIMMUNODIFFUSION. Yamaguchi, Masatoshi (Chiba Univ., Japan). Nippon Shonika Gakkai Zasshi, 73: 925-34(July 1969). (In Japanese).

Radioimmunoelectrophoresis (RIE) and radioimmunodiffusion (RID) were applied to the study of antibodies to cow's milk and bovine serum albumin in sera from normal infants and infants with various diseases. RIE distinguished antibodies only in IgG while RID demonstrated in IgG, IgA and IgM, all immunoglobulins. Antibodies were found highest in infants of 3 to 5 months old and also of around 2 years old, decreasing in general as their ages advanced. In tanned erythrocyte hemagglutination test performed for comparative study, average agglutinin was highest in 3- to 5-month old infants, increasing slightly in the 12- to 23-month old. However, it decreased in older infants in accordance with the results obtained by RIE and RID. The study on the correlation between antibody formation and various diseases indicated that circulating antibodies were highest in infantile asthma, bronchiolitis, eczema, vomiting of milk and spiloplania of unknown but presumably virus etiology, rather low in bronchial asthma and purpura in infants over 2 years of age. No antibodies were noted in infants with breast feeding, gradually increasing in the order of mixed feeding and artificial feeding. (NSA of Japan)

4546 NEW RADIOIMMUNOASSAY USING AN IMMUNOADSORBENT OF POLYMERIZED ANTI-HCG. Isojima, Shinzo; Naga, Osamu (Tokushima Univ., Japan). Nippon Naibumpi Gakkai Zasshi, 45: 595-8(Sept. 1969). (In Japanese).

A rapid radioimmunoassay for microanalysis of human chorionic gonadotropin (HCG) utilizing a simpler method of preparing an immunoadsorbent is described. Rabbit anti-HCG serum was mixed with normal rabbit serum and polymerized with ethyl chloroformate to prepare an insoluble immunoadsorbent. The specific binding of the anti-HCG polymers to ^{125}I-HCG reached the maximum in 120 minutes at 37°C, gradually decreased to approximately 80% of the maximum precipitation at 60 minutes and 60% at 30 minutes. The standard inhibition curve was then obtained from the mixture of ^{125}I-HCG, 0.005 IU in 0.3 ml, polymerized anti-HCG (1 : 200) 0.3 ml and the standard HCG (5,000IU/mg) incubated for 60 minutes at 37°C. The microanalysis of HCG proved to be possible with 60 to 120 minutes of incubation, or even 30 minutes. It was suggested that the method could also be applied to the analysis of LH by increasing the reaction sensitivity. The comparative study of this method with bioassay and other radioimmunoassay, i.e., two antibody method, indicated that the method was sufficiently useful. (NSA of Japan)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 4230, 4568, 4588, 4613, 4651, 4667, and 4675.

4547 (BNWL–1159, pp 30-5) MATHEMATICAL CONSIDERATIONS ON THE URINARY EXCRETION OF PLUTONIUM DEPOSITED IN THE LUNG. Nelson, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A mathematical model was developed that offers a more mathematically satisfactory description of the urinary excretion process for plutonium deposited in the lungs than have previous models. Though the model forms a more defensible basis for more detailed treatments, the solution of the many problems of diagnosing burdens of plutonium in workers' lungs remains obscure. (E.R.B.)

4548 (CONF-690501–7) DEVELOPMENT OF PLACENTAL DISCRIMINATION AMONG HOMOLOGOUS ELEMENTS. Schulert, A. R.; Glasser, S. R.; Stant, E. G. Jr.; Brill, A. B.; Koshakji, R. P.; Mansour, M. M. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). [1966]. 12p. Dep. CFSTI.

From 9th Annual Hanford Symposium on Radiation Biology of the Fetal and Juvenile Mammal, Richland, Wash.

Most radionuclides of the nonessential elements that are of potential hazard to man enter biological systems because of similarity to an essential element. Generally the nonessential element is discriminated against, i.e., it traverses the biological system to a lesser extent than does the related essential element. The comparative maternal-fetal transfer of homologous chemical elements was studied. Data are presented on the II-A or alkaline earth elements, namely calcium, strontium, barium, and beryllium, and the II-B triad of zinc, cadmium, and mercury. In each case attention was focused on the essential element, namely calcium and zinc as a reference base for the nonessential homologs. For each experiment either three or four γ-emitting isotopes of high specific activity were combined in saline to give an activity of about 1 μCi/ml for each isotope in the resultant solution. One ml of this solution was injected into the saphenous vein of a pregnant rat. The alkaline earth isotopes used were ^{47}Ca, ^{85}Sr or ^{87m}Sr, ^{131}Ba or ^{133}Ba, and ^{7}Be. The II-B isotopes were ^{65}Zn, ^{115m}Cd, and ^{203}Hg. (auth)

4549 EXPERIMENTAL STUDY IN RATS OF THE EFFECT OF RADON ON NORMAL LUNGS AND LUNGS EXPOSED TO SILICA DUST. Chameaud, J.; Perraud, R.; Lafuma, J.; Collet, A.; Daniel-Moussard, H. Arch. Mal. Prof. Med. Trav. Secur. Sociale, 29: 29-40(Jan.-Feb. 1968). (In French).

Rats were exposed to silica dust alone, radon alone, and a mixture of silica and radon. The apparatus used is described and tables are presented to show proportions of silica in dry lung tissue from rats exposed to silica alone and rats exposed to silica in the presence of radon. Photographs of histological sections of lungs are presented to show distribution of silica dust in the presence and absence of radon. Radon, when used alone in doses of 1.10^{-6} curie/liter, did not have an immediate injurious effect on pulmonary tissue. After radon was administered for 150 hours over a period of six months, the integrity of the parenchyma remained whole. An increase in cellular alveoli was noticed in animals subjected to radon and silica dust at the same time. Following exposure to silica in the presence of radon, diffuse fibrous lesions were found next to typical nodular formations, thickening of the septa, and infiltrated perivascular and peribronchial tubes. (H.L.W.)

4550 METABOLIC STUDIES WITH ^{65}Zn. VIII. VARIATION OF THE RELATIVE DISTRIBUTION OF ^{65}Zn IN THE GUINEA PIG. Iranzo, E.; Chueca, A.; Garcia del Amo, C.; Santos-Ruiz, A. (Facultad de Farmacia, Madrid). Rev. Espan. Fisiol., 24: 109-16(Sept. 1968). (In Spanish).

The distribution of ^{65}Zn (60 μCi/kg in one intraperitoneal dose) was studied in organs of guinea pigs from 6 to 140 days postinjection. After 6, 15, 27, 45, 60, 80, and 140 days the animals were killed and the ^{65}Zn content was determined in the carcass, skin and hair, encephalon, eyes, nails, teeth, liver, pancreas, spleen, stomach, intestine, kidneys, and adrenals, male genital apparatus, lungs, and heart. The results showed that the carcass and especially the osseous system were the main sites of ^{65}Zn deposits, with 58% of the body burden. The accumulation there remained practically constant within the 27- to 140-day period. The skin and hair, especially the hair, constituted the next most important site of ^{65}Zn accumulation. The third site of ^{65}Zn deposition was the kidneys and adrenals with an approximate value of 1.5%. The nails, allowing for their small total mass, represented another site of deposition, or ~0.35%. The thoracic and abdominal organs made less contribution to the body burden such that within the period 6 and 140 days the value of 31% was reduced by a tenth. The teeth and encephalon presented similar variations. After a period of increase until the 22nd day, when the ^{65}Zn contents were 5.5% and 0.5%, respectively, these values then decreased gradually to give values of 2.9% and 0.27% on the 140th day. (BBB)

4551 THE DISTRIBUTION OF ^{65}Zn IN THE PROSTATE AND OTHER ORGANS IN CONTROL, CASTRATED, AND HYPOPHYSECTOMIZED RATS. Byar, David P.; Anderson, James E.; Mostofi, K. F. (Armed Forces Inst. of Pathology, Washington, D. C.). Invest. Urol., 7: 57-65(July 1969).

The content of ^{65}Zn in the organs of rats was studied to determine whether castration or hypophysectomy affected the distribution of the isotope in the body, and as an index to the specificity of hormone-dependent uptake for the prostate. At ages between 20 and 30 weeks the rats were given a 0.5-ml injection of ^{65}Zn subcutaneously in the dorsum of the right thigh. The solution contained 37.2 μg of Zn/ml with a sp act. that varied from 9.64 to 7.18 μCi/ml. This corresponded to an injection of 18.6 μg of elemental Zn, or 43.3 μg/kg, a small amount compared to the estimated normal Zn intake of the rat, 500 μg per day. The mean tissue ^{65}Zn content for all organs, except the brain in the control animals, exceeded the blood level. The ratios for various organs or groups of organs compared to blood were: dorsolateral prostate, 23 : 1; abdominal viscera (liver, pancreas, kidney, spleen, adrenal), 6 to 16 : 1; thoracic viscera (lung, heart, esophagus), and other genital organs (seminal vesicle, ventral prostate, testis, epididymis), 2 to 6 : 1; skeletal muscle, 1.5 : 1. Values for the content of ^{65}Zn in dorsolateral prostate were markedly decreased in the castrated and hypophysectomized animals, but values for all other organs were similar in the three groups. Although the dorsolateral prostate of the control animals had the highest content of ^{65}Zn per unit wt, this organ concentrated only about 1% of the administered dose. (BBB)

4552 TRANSPORT OF GOLD IN THE BODY. McQueen, E. G. (Univ. of Otago, Dunedin, N. Z.); Dykes, P. W. Ann. Rheum. Dis., 28: 437-42(July 1969).

Mode of transport of ^{198}Au in the blood of rabbits was studied. Some rabbits were pretreated with nonradioactive Au. The colloidal ^{198}Au used had an activity of 1.95 μCi/ml and a gold content of 0.16 mg/ml. The ^{198}Au half-life of 2.7 days limited the duration of these experiments to 1 week. Each rabbit was given 1 ml of the radiogold colloid, injected deeply into the thigh muscles on the right side. Three and 24 hr and 6 days after administration of isotope, blood was collected from an ear vein and the radioactivity estimated. The level of total Au was very high in samples taken at 3 and at 24 hr. Blood levels were related to the total dose of Au given at the same time as the isotope but were not related to whether or not the animals were pretreated. Radioactivity in the blood samples, however, was lower in the rabbits receiving the high total Au dose than in those on the low dose. On Sephadex fractionation, radioactivity was found to be confined to the albumin peak. Autoradiography after immunoelectrophoresis indicated further the association of radioactivity with the albumin fraction. Likewise, on filter-paper electrophoresis, radioactivity was principally in the albumin fraction. Radioactivity in various organs in animals killed on the 7th day was determined. Active uptake of ^{198}Au by tissues was much more striking in the kidney cortex than elsewhere. Renal medullary levels were quite low. Among other organs examined, only spleen showed levels which were notably higher than those in the blood. The relatively rapid fall in blood levels was obviously due to uptake by the tissues as urinary excretion was inadequate to account for this, and fecal excretion was even less. (BBB)

4553 ^{65}Zn METABOLISM: EFFECT OF CONTINUOUS INFUSION OF HIGH LEVELS OF STABLE ZINC IN SWINE. Pekas, Jerome C. (Univ. of Tennessee, Oak Ridge). J. Anim. Sci., 27: 1559-66(Nov. 1968).

The effect of continuous parenteral administration of stable Zn on the translocation of ^{65}Zn, administered 24 hr earlier under steady-state conditions, was studied. The ^{65}Zn was administered intravenously to the pig, in some instances along with intravenous infusion of stable zinc at various rates, from 0.25 to 2.50 mg Zn/kg/hr. Homeostatic mechanisms for positive clearance of excess Zn in the pig were exceeded by the infusion of 0.25 mg Zn/kg/hr. Zinc-65 was removed rapidly from the blood by the tissues but exchanged with infused stable Zn, causing the ^{65}Zn of tissues saturated with Zn (i.e., muscle) to be translocated to unsaturated tissues (liver, pancreas, kidney, and lung). Saturated tissues are characterized by no net change in total Zn content after stable Zn infusion, and unsaturated tissues by a marked increase in Zn content. However, the Zn of the saturated and unsaturated tissues is in equilibrium, suggesting that the Zn from either type of tissue can exchange with the Zn of the other type of tissue. (BBB)

4554 TRANSFERENCE OF RADIOACTIVE SUBSTANCES FROM THE MOTHER TO THE FETUS. Ovcharenko, E. P. Med. Radiol., 14: No. 2, 61-8(Feb. 1969). (In Russian).

The study of the mechanisms of penetration of radioactive isotopes through the placental barrier from the body of the mother to the fetus is necessary and urgent in the light of the constantly increased contact of the population with radioactive substances. The possibility of penetration through the placenta was demonstrated for almost all of the radioactive isotopes studied. However, in quantitative relation, the differences in placental transfer varied by a factor of 100. In the present review an attempt is made to clarify the general quantitative rules of radioactive isotope transfer through the placenta. The degree of transfer depends on the nature of the contact between the blood of the mother and the fetus as determined by the histological structure of the placenta, and the physical-chemical properties of the radioactive isotopes. On the basis of an analysis of the literature, it is concluded that the quantity of radioactive isotopes transfered through the placenta to the fetus depends on the physiological conditions and the positions of the element in the periodic table. For all of the radioactive isotopes studied, there was a significant increase of transfer through the placenta in the late periods of pregnancy. The histological structure of the placenta had a significant influence on the quantity of radioisotope transfered. Following the introduction of radioactive isotopes during pregnancy, a relation between the time of introduction of the elements, the kinds of isotopes, and their quantity was noted regarding passage into the fetus. For the group I, II, and VIII elements, a relation between the mass number of the isotope and its passage into the fetus was noted. To establish similar relations among the other groups of elements is not possible because of the lack of sufficient data. The radioactive isotopes of hydrogen, calcium, phosphorus, iodine, and iron possess the greatest capability to penetrate through the placenta. However, the danger of the presence of radioactive isotopes in the body of the pregnant woman, according to observations, is not reduced by the quantity of their transfer through the placenta. Known data concerning the significant retention of plutonium in the placenta makes necessary the investigation of it and other radioactive isotopes with larger mass numbers. In connection with the important role of placental damage in the development of radiation embryopathy there is a need to study the influence of these isotopes that are present in the body of the mother during pregnancy. (tr-auth)

4555 TRANSFER OF ^{144}Ce TO MOUSE EMBRYOS AND OFFSPRING VIA PLACENTA AND LACTATION. Naharin, A.; Lubin, E.; Feige, Y. (Soreq Nuclear Research Centre, Yavne, Israel). Health Phys.; 17: 717-22(1969).

Female albino mice were injected intramuscularly with ^{144}Ce-citrate, and mated at different periods. Their litters were whole-body counted immediately after delivery and thereafter for another 60 days, and the results compared to the body burden of their mothers. Some fetuses were extracted by Caesarian intervention 24 hr before expected delivery and whole-body counted. The distribution of ^{144}Ce in various organs of the adult female mice, as well as of some suckling young mice, was also studied, as a function of time. The passage of ^{144}Ce through the placenta when the isotope is readily available in the circulation was clearly demonstrated. In cases where there were long intervals between the administration of the isotope and delivery, placental transfer was also evident, but further investigation would be desirable. There was a clear increase in radioactivity in the litters during the suckling period even in those delivered several months after the contamination of the mother, when the Ce is already concentrated mainly in the mother's skeleton. Absorption of cerium from the gastrointestinal tract was found to be about 1.5% of the total intake during the suckling period. This, if confirmed, would suggest that the discriminatory ability of the gastrointestinal tract is not as efficient in mice during the early period of life, as in the adult stage. (auth) (UK)

4556 EFFECT OF INCREASED CITRATE CONTENT INDUCED BY FLUOROACETATE ON THE METABOLISM OF ^{144}Ce IN SOME ORGANS OF RAT. Szot, Zbigniew (Inst. of Nuclear Research, Warsaw); Geisler; Czechowska, Zofia. Nukleonika, 14: 307-17(1969).

Sodium fluoroacetate was administered to rats in order to increase the citrate content, and $^{144}CeCl_3$ was injected. Decreased deposition of ^{144}Ce in bone and parenchymal organs was observed, provided fluoroacetate did not damage the parenchymal cells. (auth)

4557 DISTRIBUTION OF ^{65}Zn IN MICE BRAIN. I. TOPOGRAPHIC PECULIARITY OF THE DISTRIBUTION OF ^{65}Zn IN THE BRAIN OF INTACT MICE. Fujii, Masataka (Yamaguchi Univ., Ube, Japan). Bull. Yamaguchi Med. Sch., 14: 97-104 (Mar. 1967).

Male dd strain mice were injected subcutaneously with 4 μCi of ^{65}Zn (as $ZnCl_2$), and concentrations of ^{65}Zn were compared in 5 parts of brain up to 720 hr later by radioassay. Autoradiography was also carried out after intracerebral injection of ^{65}Zn. The ^{65}Zn activity in each brain component examined was maximal at 48 to 120 hr. The activity did not show significant differences from one part to another. The ^{65}Zn activity decreased after 120 hr. The rate at which ^{65}Zn decreased in the hippocampus major was slower than that in other parts. At the late intervals, the 5 parts of the brain could be arranged in 3 groups according to ^{65}Zn activity. The diencephalon and mesencephalon, pons, and medulla oblongata showed low activity, while the activity of the cerebrum and cerebellum was high. The hippocampus major showed the highest ^{65}Zn activity. In the autoradiographic study, the high density of ^{65}Zn was observed in the marginal part of stratum radiatum of $h_4 \cdot h_5$ area which is contact with stratum pyramidale of the hippocampus and stratum multiforme of the dentate gyrus. (BBB)

4558 CORRELATION OF THE VALUES OF THYROID UPTAKE OF STABLE IODINE (^{127}I) AND RADIOIODINE (^{131}I). Solsona, Fernando; Martinez Comin, Pilar. Rev. Iber. Endocrinol., 14: 595-609(Nov.-Dec. 1967). (In Spanish).

Theoretical aspects of radioiodine metabolism are considered and a computer program developed for assessing the reliability of isotope methods in determining thyroid activity. How the ^{131}I uptake by the thyroid depends on several factors, among them the inorganic iodide content of blood, is discussed. This fact diminishes its diagnostic accuracy. On the other hand, the determination of ^{127}I uptake (by combined isotopic and microchemical procedures) is much more reliable. In this report a positive correlation between values of ^{127}I and ^{131}I uptake was demonstrated in three different situations: plasma iodide values in the range of 1 a 3 μg/l, over 3 μg/l, and under 1 μg/l. The depletion of the iodide pool causes a false increase in the ^{131}I uptake by the thyroid. Conversely, saturation of the blood with iodide results in a ^{131}I thyroid incorporation value which is lower than the actual value. Both of these situations are avoided when ^{127}I is used to determine thyroid iodine uptake. (BBB)

Radiation Effects

Refer also to abstracts 4307, 4308, and 4334.

4559 (AEC-tr-7036) FREE RADICAL PROCESSES IN BIOLOGICAL SYSTEMS. Translation of Trudy Moskovskogo Obshchestva Ispytatelei Prirody, Vol. XVI, Otdel Biologicheskii, Sektsiya Biofiziki i Radiobiologii, Nauka Publishing House, Moscow, 1966. 550p. Dep. CFSTI.

An English language translation of the proceedings of the Russian symposium on Free Radical Processes in Biological Systems is presented. The translation contains all 62 of the original papers and the introductory and concluding remarks. Twenty-four of the original Russian language papers were previously abstracted and appeared in Vol. 22 of NSA. (E.R.B.)

4560 (NYO-910-121) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 1. RADIATION STUDIES. 1. FREE RADICAL PRODUCTION IN BIOLOGICALLY SIGNIFICANT COMPOUNDS. 2. THEORETICAL INVESTIGATION OF ELECTRON LET SPECTRA AND DOSE RELATIONSHIP FOR IONIZING RADIATIONS. Progress Report, May 1, 1968–May 1, 1969. Laughlin, John S.; Pullman, Ira; Kessaris, Nikitas D. (Sloan-Kettering Inst. for Cancer Research, New York). Sept. 30, 1969. Contract AT(30-1)-910. 9p. Dep. CFSTI.

Progress is reported on free radical production in biologically significant compounds and on theoretical investigations of electron LET spectra and dose relations for ionizing radiations. Areas investigated were protective mechanisms in x-irradiated systems of DNA and Sulfhydryl compounds (ESR spectroscopy studies), the negative ions of polycyclic hydrocarbons, assay of free radicals in uv-irradiated purine N-oxides, spin-labeling studies for analysis of hormone-membrane interactions, and electronic instrumentation for ESR studies in relation to computer analysis. The mathematical analysis of phenomena that take place during and after irradiation with very high intensity pulsed electron beams is being sought for the observed break in the survival curves from the expected oxygenated condition to a condition of anoxia at or above a certain dose. A set of depth-dose and dose-LET distributions in water for cyclotron-produced neutron beams is discussed and the variations of the ratio of absorbed dose to cavity ionization as a function of depth penetration of a 20 MeV electron beam in carbon is presented in graphic form. (C.O.)

4561 (ORO-3329-5) EFFECT OF RADIATION ON MUCOSAL PHOSPHOLIPASE ACTIVITY. Progress Report. (Duke Univ., Durham, N. C. Dept. of Physiology and Pharmacology). Oct. 1969. Contract AT(40-1)-3329. 17p. Dep. CFSTI.

Experiments confirmed the thesis that the two phospholipase activities (lecithinase and phospholipase B) coexist in most tissues including the hematopoietic organs. Activation of the enzymes was produced by simple incubation with glycerol when intact cells are used. The intimate mechanism of this action is not defined by our experimental data: both osmotic and solvent effects could be involved resulting in a more appropriate molecular conformation of the enzyme supporting sustained high reaction rates. One important point emerging from these experiments is the striking similarity in behavior of the enzyme prepared from different tissues; this is believed to be a reflection of localization in a single cell type. Preliminary experiments with 600 R whole body x irradiation of rats with bone marrow sampling at 5, 8, 11, 14, and 27 days after exposure showed clearly the fall and restoration in marrow cellularity and the corresponding variations in phospholipase B activity accompanied by the expected lowering of the activity per unit cell. (C.O.)

4562 (UR-49-1185) EFFECTS OF X-IRRADIATION UPON THE METABOLISM OF FIBRINOGEN AND OTHER PLASMA PROTEINS IN RATS. Irwin, John Foster (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1969. 137p. Dep. CFSTI.

Thesis.

The effect of irradiation (655 R) upon the degradation and distribution of ^{131}I-fibrinogen in rats was examined at various times up to 45 days post-irradiation. Extravascular ^{131}I activities of various tissues were determined using a method of calculation which involves the use of both ^{131}I-fibrinogen and ^{125}I-fibrinogen. The apparent whole-body fractional catabolic rate of ^{131}I-fibrinogen was greater in irradiated animals than in control animals immediately after irradiation. However, there was no apparent difference in the whole-body degradation of fibrinogen when animals were irradiated during the metabolic study. The rate at which ^{131}I-fibrinogen was removed from the vascular space was greater than normal following irradiation. There appeared to be a progressive accumulation of ^{131}I-fibrinogen by the extravascular spaces of irradiated animals. Skin, bone, lung, muscle, and small intestine and its contents were responsible, in part, for the accumulation of fibrinogen. The results of these experiments suggest that fibrinogen is equilibrated with a larger extravascular space as well as degraded more rapidly in irradiated animals than in control animals. The apparent half-life of ^{131}I-fibrinogen in 30-day survivors of irradiation was 1.3 days compared with 1.5 days in control animals. There was also a larger extravascular space in irradiated animals than in control animals, part of which was attributable to the small intestine. It was concluded that the metabolism of fibrinogen in irradiated animals was normal but that the processes effecting metabolism were at a different level of operation than they were in control animals. The apparent whole-body half-lives of ^{131}I-fibrinogen and of ^{131}I-albumin were 1.6 and 2.7 days, respectively, in both irradiated and control animals at 6 weeks post-irradiation. The clearance of ^{131}I-fibrinogen from the vascular space was greater in irradiated animals than in control animals up to 12 days post-irradiation, after which time it was no different from control values. Enhanced clearance of ^{131}I-fibrinogen from the body of irradiated animals was apparent only from 5 to 9 days post-irradiation. The levels of several specific plasma proteins were measured serologically up to 45 days post-irradiation. Albumin levels were decreased as early as 2 days, although maximum decreases were not apparent until day 9. Fibrinogen, α_1-acid glycoprotein, α_2-(acute phase) globulin, and haptoglobin levels were markedly elevated from 5 to 12 days. There was also a moderate increase in haptoglobin levels by 24 hours which was sustained until the second phase occurred. Normal levels of these proteins were reestablished by 16 days post-irradiation. The effect of irradiation upon the degradation of 1-^{14}C-L-leucine-labeled plasma proteins and upon the oxidation of 1-^{14}C-L-leucine was also examined in intact and eviscerated rats. The cumulative percent dose of $^{14}CO_2$ collected during a 5- or 6-hour period was used as a minimal estimate of leucine oxidation or protein degradation. In intact animal studies irradiated animals degraded 1-^{14}C-leucine-labeled plasma proteins to a greater extent than did control animals at 3 days after 655 R and at 1 and 3 days after 750 R. There was no difference in degradation at 1 day after 655 R. These conclusions were confirmed by the fact that there was no difference in the capacity of either group of animals to oxidize 1-^{14}C-L-leucine to $^{14}CO_2$. In eviscerated surviving rat studies which were carried out at various times up to 40 days post-irradiation (655 R), irradiated animals appeared to degrade 1-^{14}C-leucine-labeled plasma proteins to a greater extent under nonloading conditions of carrier leucine than did control animals. This was apparent up to 7 days post-irradiation but not after this time. However, the degradation of 1-^{14}C-leucine-labeled plasma proteins was greater in irradiated rats only at 1 day if carrier leucine was infused during the course of the experiment. These results suggest that there is net increase in degradation of 1-^{14}C-leucine-labeled plasma proteins only at 1 day post-irradiation. (auth)

4563 EFFECTS OF WHOLE BODY IRRADIATION ON BLOOD SUGAR LEVEL OF THE SCORPION ANDROCTONUS AUSTRALIS L. **Goyffon, M.; Schantz, R.; Niaussat, P. (Laboratoire d'Etudes et de Recherches sur les Animaux Irradies, Paris). Compt. Rend. Soc. Biol., 163: 601-5(1969). (In French).**

Whole-body γ irradiation of the scorpion, Androctonus australis, resulted in a distinct phase of hypoglycemia which lasted for three weeks and was followed by a shorter phase of relative hyperglycemia. This result, obtained in a radioresistant species, differs from that obtained in mammals by the absence of an early hyperglycemic phase after irradiation, and by a spreading in time of variations in glycemia. (tr-auth)

4564 ACTION OF ULTRAVIOLET IRRADIATION ON THE ACTIVITY OF TWO AMINO ACID DECARBOXYLASES IN THE PRESENCE OF PHOSPHO-5'-PYRIDOXAL AND PHOSPHO-5'-PYRIDOXAL ISONICOTYLHYDRAZONE. **Gonnard, Pierre; Camier, Maryse; Rodrigues, Luiz Erlon A. (Lab. de Chimie Biologique, Maison de Nanterre, France). Bull. Soc. Chim. Biol., 50: 1759-68(1968). (In French).**

A 30-W Philips mercury vapor lamp was used to irradiate dopa-decarboxylase, glutamate decarboxylase, phospho-5'-pyridoxal (PLP), and phospho-5'-pyridoxal isonicotylhydrazone (INHPLP). PLP was modified by irradiation as shown by a diminution of its coenzymatic activity. INHPLP was unchanged by uv irradiation. Irradiation irregularly modified the apoenzymes: dopa-decarboxylase was partly denatured and glutamate decarboxylase remained unchanged. Glutamate decarboxylase activity was reduced when irradiated in the presence of PLP, or if PLP added had been irradiated separately. Under similar conditions irradiation with INHPLP present, or after addition of irradiated INHPLP, caused no modification of enzyme activity. If INHPLP must be split in INH and PLP to be active, uv irradiation could induce a modification of PLP liberated and consequently a diminution of enzymatic activity. Since this activity was unchanged, it was concluded that hydrazone was not split. (BBB)

4565 CHANGES IN GLYCOLYSIS OF RAT THYMOCYTES AFTER A WHOLE-BODY X-IRRADIATION. **Yamada, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan); Ohyamas, Harumi; Kumatori, Toshiyuki; Minakami, Shegeki. Int. J. Radiat. Biol., 15: 497-506(1969).**

The aerobic production of lactate by suspensions of thymocytes prepared from irradiated rats was considerably increased in the early phase after a whole-body x-irradiation with 400 R. Intracellular concentrations of intermediates and co-factors of glycolysis were measured at various times up to 6 hours after the irradiation. Fructose-1,6-diphosphate showed a remarkable increase in the cells of rats killed immediately after the exposure. The changes in the levels of intermediates suggest the enhanced activity of phosphofructokinase in thymocytes after whole-body irradiation, as previously observed following in vitro irradiation. (auth)

4566 EFFECTS OF γ RADIATIONS ON THE INCORPORATION OF TRITIATED URIDINE BY HeLa CELLS. Cappelaere, P.; Herbin, Y.; Driessens, J. (Institut de Recherche sur le Cancer, Lille). Compt. Rend. Soc. Biol., 163: 658-62(1969). (In French).

HeLa cells, cultured according to standard techniques, were irradiated using a telecobalt therapy apparatus at a rate of 10 rads/min, a focal distance of 120 cm, and at doses of 150, 400, and 700 rads. Immediately after irradiation the culture medium was renewed. The incorporation of uridine was studied 90 min, 48 hr, and 4 days after irradiation. The cells incorporated tritiated uridine in all stages of the cell cycle except during the metaphase and anaphase. Incorporation occurred in the nucleus at first and later in both the nucleus and cytoplasm. Gamma irradiation of HeLa cells hardly modified the incorporation of tritiated uridine quantitatively; when under comparable experimental conditions the incorporation of tritiated thymidine is sharply reduced. Irradiation involves a late inversion of intracellular distribution of tritiated uridine at the expense of the cytoplasm when initially it is the nuclear radioactivity that is diminished. (H.L.W.)

4567 THE EFFECT OF PRELIMINARY X IRRADIATION ON RESORPTION OF 7,12-DIMETHYLBENZ-[a]-ANTHRACENE IN MICE SKIN. **Turusov, V. S. (Inst. of Experimental and Clinical Oncology, Moscow). Vop. Onkol.; 15: No. 9, 45-9(1969). (In Russian).**

The intensity of fluorescence of skin in living mice after application of various doses of 7,12-dimethylbenz [a] anthracene (DMBA) was studied by a quantitative method. Irradiation in doses 2000 and 4000 R immediately prior to application of DMBA rendered no significant effect on duration of its fluorescence on the skin. Application of DMBA one week following irradiation resulted in a considerably longer time of fluorescence in comparison with control animals. The increased period of DMBA fluorescence in previously irradiated skin is related to destructive changes in tissues, induced by radiation, and continuous fixation of the carcinogen in them. (C.O.)

4568 CONTRIBUTION TO THE STUDY OF RADIOCONTAMINATION OF DOMESTIC ANIMALS. **Gligorijevic, J.; Begovic, Jevrosima; Draganovic, B.; Zagorcic, Anica (Inst. for Applied Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Acta Vet. (Belgrade); 18: 177-86(1969). (In Slovak).**

Various radioisotopes were studied as to their effects on rats, swine, dogs, and hens. External contamination of dogs with ^{137}Cs and ^{144}Ce initially led to rapid transcutaneous absorption, but later only the hair follicles contained the isotope. External contamination of hens with a mixture of ^{85}Sr and ^{89}Sr led to rapid transcutaneous absorption in the neck region, and much slower absorption in the skin area of the legs. External contamination of rats with ^{137}Cs penetrated to the circulating blood within 15 minutes. Predominantly, penetration occurred at hair follicles and ducts of skin glands. Internal contamination of hens with a mixture of ^{85}Sr and ^{89}Sr led to cycles of deposition and mobilization that affected both skeleton and egg shell in normal animals and in hens having received x-ray exposure from 800 to 1600 rads. (H.B.G.)

4569 CONTRIBUTION TO THE INVESTIGATION OF EFFECT OF WHOLE-BODY γ RADIATION OF LETHAL LEVEL ON RESTORATIVE PROCESSES IN THE EFFECT OF SKIN. Stajic, Jovan S. (Inst. for Roentgenology and Physical Therapy, Belgrade. Inst. for Technical-Medical Protection, Belgrade). Acta Vet. (Belgrade); 18: 233-50(1969). (In Slovak).

The combination of radiation injury and mechanical lesions, inflicted 2 hr postexposure, was studied in the skin of rats exposed to 700 rads of ^{60}Co γ radiation. During two weeks after exposure, collagen formation was delayed and tensile strength was diminished. The wound healing time was, under the effect of radiation, statistically prolonged. The processes of biochemical, biophysical, and histomorphological restoration were also delayed by radiation. (H.B.G.)

4570 CHANGE IN GLYCOLYSIS OF RAT THYMOCYTES AFTER A WHOLD BODY X-IRRADIATION. **Yamada, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan); Ohyama, Harumi; Kumatori, Toshiyuki; Minakami, Shigeki. Int. J. Radiat. Biol.; 15: 497-506(1969).**

The aerobic production of lactate by suspensions of thymocytes prepared from irradiated rats was considerably increased in the early phase after a whole-body x irradiation with 400 R. Intracellular concentrations of intermediates and co-factors of glycolysis were measured at various times up to 6 hours after the irradiation. Fructose-1,6-diphosphate showed a remarkable increase in the cells of rats killed immediately after the exposure. The changes in the levels of intermediates suggest the enhanced activity of phosphofructokinase in thymocytes after whole-body irradiation, as previously observed following in vitro irradiation. (auth) (UK)

4571 CYCLIC LABELING OF MAMMALIAN CELL DNA AFTER X-IRRADIATION: LABELING WITH SPECIFIC PRECURSORS. **Sanders, J. L.; Dalrymple, Glenn V.; Baker, Max L.; Moss, A. J. Jr.; Nash, J. C. (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock). Proc. Soc. Exp. Biol. Med., 132: 362-6(Oct. 1969).**

Starved L cells show a radiation-induced cyclic labeling of the acid-insoluble fraction when adenosine and deoxyadenosine are used as tritium-labeled precursors. The response consisted of a rapid uptake and loss of label. A similar effect has also been reported for ^{32}P labeling of DNA. These findings support the idea that x irradiation of mammalian cells produces increased action of an enzyme which rejoins single-strand breaks in DNA. The enzyme mechanism involves formation of a transient DNA-adenylate complex. In such a reaction, labeled adenylate should enter and then leave the DNA fraction. The results reported here agree with such a mechanism. (auth)

4572 EFFECT OF X-RAYS AND RADIAL ACCELERATIONS ON COMPOSITION OF WATER-SOLUBLE PROTEINS OF BLOOD SERUM, HEART, AND MUSCLES. **Ivanyura, I. O. (Lvov State Univ.). Ukr. Biokhim Zh.; 41: 444-7(1969). (In Ukrainian).**

The change in the composition of water-soluble proteins in blood serum, heart, and muscles of albino mice was studied under the effect of X-rays in combination with radial accelerations. Under the effect of radial accelerations the qualitative and quantitative changes are observed in the composition of the water-soluble proteins of the mentioned tissues. The results of the investigation testify to the fact that the changes in the composition of the water-soluble proteins in the tissues of the animal organs subjected to the radiation and radial accelerations differ from those arising under the effect of each factor separately. The changes in the system of blood serum, muscles and heart proteins of animals observed after the effect of ionizing radiation deepen under complex radiation and multiple radial accelerations. (auth)

4573 EPR SPECTRA OF LYOPHILIZED IRRADIATED MICROORGANISMS. **Kononenko, K. I.; Golubnichaya, G. V. (Gorky Kharkov State Univ., USSR). Biophysics (USSR) (Engl. Transl.), 13: 1208-12(1968).**

Translated from Biofizika, 13: 1036-9(1968).

The EPR spectra of 18 variants of lyophilized microorganisms: yeasts, molds, and bacteria was obtained before and after ^{60}Co γ irradiation. It has been established that the EPR spectra of the unirradiated molds are more intense than the EPR spectra of yeasts and bacteria. The EPR spectra of the irradiated yeasts and bacteria differed little. The EPR spectra of the irradiated molds sharply differed from those of irradiated yeasts and bacteria in the width, symmetry, and intensity of the line. On irradiation the EPR signals of the yeasts and bacteria rose more than the EPR signals of the molds. The width of the EPR curve for yeasts and bacteria on irradiation increased and the width of the EPR curve of the molds remained unchanged. (auth)

4574 MEASUREMENT OF THE FREE AND THE H-BONDED AMIDES OF MYOGLOBIN. **Englander, S. W.; Staley, R. (Univ. of Pennsylvania, Philadelphia). J. Mol. Biol.; 45: 277-95(28 Oct 1969).**

It has become abundantly clear that the rather slowly exchanging hydrogens of a protein do not simply relate to α-helix content. Some of the other inferences reached in the early period of protein hydrogen exchange work do still appear to be valid, namely, that most side chain hydrogens exchange instantaneously and that H-bonded amides exchange very slowly. However, in conflict with the older equation of slow hydrogens with α-helix are the more recently demonstrated facts that proteins possess H-bonded amides other than those in α-helix, which may also be expected to exchange very slowly, and that amides even when free can exchange measurably slowly, though perhaps not nearly as slowly as those in hydrogen bonds. Thus, rather than absolute separation between "instantaneous" and slow hydrogen exchange classes, differentiation between relatively faster and relatively slower kinetic classes seems indicated. Such a separation might provide a measure of structure representing the over-all number of H-bonded amides rather than just α-helix. A successful test of this expectation was carried out with myoglobin. To perform this test, the fairly rapidly exchanging hydrogens of myoglobin were preferentially labeled by brief exposure to tritiated water, and their exchange-out behavior was studied. The exchange-out of these faster hydrogens convincingly match theoretical exchange curves for free amide groups. These theoretical curves were constructed using the numbers of free amide groups in the myoglobin crystallographic model and hydrogen exchange rates found for such groups in model polymers. By a less demanding variant of this same exchange-in/exchange-out approach, the number of abnormally slowly exchanging hydrogens was independently determined and found to match the number of internally H-bonded amides in the myoglobin model structure. The good agreement found is taken as establishing the identity of the free and the H-bonded amides of myoglobin with distinguishable kinetic classes of exchanging hydrogens. The results demonstrate that, for this protein, free amides show simple and predictable hydrogen exchange behavior, that essentially all H-bonded amides exchange much more slowly, and that essentially all the other side chains exchange considerably faster. Evidence was found for the importance of an opening-dependent pathway for slowly exchanging, H-bonded hydrogens of myoglobin, as opposed to some direct exchange mechanism not dependent on conformational movement. The present study also provides another parameter common to both crystalline and dissolved myoglobin, namely, the number of H-bonded (donor) peptide groups. (auth)

4575 STRUCTURE OF ALKALINE METMYOGLOBIN–XENON COMPLEX. **Schoenborn, Benno P. (Brookhaven National Lab., Upton, N. Y.). J. Mol. Biol.; 45: 297-303 (28 Oct 1969).**

Structural changes of alkaline metmyoglobin compared to neutral metmyoglobin have been determined by a three-dimensional x-ray diffraction analysis. Alkaline metmyoglobin crystals proved, however, to be somewhat unstable under x-irradiation. Exposure of crystals to xenon stabilized them thus permitting the necessary extended x-ray exposures. Structural changes were determined by inspection of difference electron density maps with subsequent refinement by a difference least-squares method. The results show two xenon binding sites in addition to a number of structural rearrangements. (auth)

Immunology

Refer also to abstracts 4545 and 4700.

4576 IMMUNOLOGICAL REACTIVITY OF PURIFIED HUMAN PARATHYROID HORMONE. **O'Riordan, J. L. H.; Aurbach, G. D.; Potts, J. T. Jr. (National Inst. of Health, Bethesda, Md.). Proc. Nat. Acad. Sci. U. S., 63: 692-8(July 1969).**

Immunological differences between human and bovine parathyroid hormones are detected with highly purified preparations of each hormone and several antisera produced against bovine parathyroid hormone. The immunological differences found show the necessity for using a reference preparation of human hormone in assays for parathyroid hormone in human serum. (auth)

4577 MEASUREMENT OF HORMONES BY RADIOSTEREOASSAY. **Shizume, Kazuo (Toranomon Hospital, Tokyo). Naika, 24: 80-4(July 1969). (In Japanese).**

The principles of radiostereoassay are based on the specific protein binding of hormones; that is, a hormone binds specifically to a certain protein, and microanalysis is carried out with radioisotope tracers. The method is described from the viewpoints of radioimmunoassay and competitive protein binding analysis of proteins, especially serum proteins for the diagnosis of endocrine diseases. The hormones measured by this technique include insulin, growth hormone, ACTH, TSH, LH, FSH, oxytocin, vasopressin, HCG, beta-MSH, glucagon, parathyroid hormone and angiotensin. As label, ^{131}I or ^{125}I is used. Competitive protein binding analysis is applied to the microanalysis of thyroid hormone and steroid hormone and also of thyroxine, cortisol, aldosterone, progesterone and estradiol. Thyroxine is usually labeled with ^{131}I or ^{125}I and steroid hormone with ^{3}H. For measurement, a liquid scintillation counter has to be used in this technique instead of the simpler gamma counter which is used in radioimmunoassay. (NSAJ)

4578 VACCINATION AGAINST DICTYOCAULUS FILARIA IN SHEEP WITH ORAL ADMINISTRATION OF 3rd STAGE LARVAE IRRADIATED WITH ^{60}Co: EXPERIMENTAL STUDIES WITH 45-DAY-OLD LAMBS. **Casarosa, Lisimaco; Macchioni, Guido; Marconcini, Alberto (Univ., Pisa). Arch. Vet. Ital., 19: 321-36(Oct. 31, 1968). (In Italian).**

The effectiveness of vaccination with 3rd stage larvae of Dictyocaulus filaria irradiated by ^{60}Co in 45-day-old lambs was investigated. The animals were kept in isolation from birth to avoid, as much as possible, infections and infestations which are frequent in the first months of life in this animal species. Under the conditions described, three vaccination regimes, namely 500, 1000, and 1000 larvae irradiated with 60,000, 60,000, and 50,000 R, respectively, immunized the lambs against a challenge infection of 4000 3rd-stage larvae of D. filaria, 15 days after the last vaccination. The protection was 94.65% complete, on the average, in comparison with nonvaccinated controls, with a minimum of 89.14% and maximum of 99.29%. In the vaccination and postchallenge periods excretion of larvae was never observed in vaccinated animals, unlike the controls. The gain in body wt of the vaccinated sheep was considerably greater than that of the controls. The wt increased from 10.4 Kg at 45 days of age to 16.4 Kg to 155 days of age in vaccinated and from 10.2 to 13.0 Kg in control sheep. (BBB)

4579 SPECIFIC ANAMNESTIC IMMUNE RESPONSE INDUCED BY PLANT MITOGENS. **Maekelae, O.; Pasanen, V. J. (State Serum Inst., Helsinki). Int. Arch. Allergy Appl. Immunol., 35: 468-75(1969).**

By use of irradiated recipient mice, attempts were made to distinguish between an increased release of preformed antibody (early phenomenon) and a true secondary response (peak 1 to 2 weeks after challenge). Donor mice were immunized with a single injection of antigen without Freund's adjuvant, and used at least 4 weeks later. The antigen was 3-iodohydroxy-5-nitrophenyl acetic acid (NIP) conjugated with chicken globulin (CG). All experimental animals were CBA mice. Donors were immunized intraperitoneally with 0.1 mg of alum-precipitated antigen. Four to 8 weeks later cell suspensions were prepared from their spleens. The cells were injected into heparinized recipients that had received 700 R of radiation 1 day previously. The stimulator, plant mitogen or NIP-CG, was given 1 hr later. Ten million syngeneic lymphoid cells from donors immunized against NIP were injected into the irradiated mice. The mitogens caused a distinct antibody response (antibody titers 2 to 100-fold higher than in nonstimulated recipients). This response was much smaller than the response to NIP. A mitogen response that was 100 times higher than the background antibody production was only 1/1500 of the antigen response. (BBB)

4580 CELL TRANSFER STUDIES IN IMMUNOSUPPRESSED MICE: THE ROLE OF THE MACROPHAGE. **Frisch, A. W.; Wilson, B. J. (Univ. of Oregon, Portland). Proc. Soc. Exp. Biol. Med., 132: 42-5(Oct. 1969).**

In cell transfer experiments C$_3$H recipient mice, which had been immunosuppressed by cycloleucine, were capable of initiating a primary response to sheep erythrocytes if they were given macrophage—antigen mixtures from normal or from Cytoxan-treated donors. Similarly prepared macrophages from cycloleucine-treated donors and crude cell suspensions derived from normal spleens were ineffective. If the recipients were immunosuppressed with Cytoxan, the results were reversed, in that normal spleen cell—antigen mixtures stimulated antibody synthesis but normal macrophage—antigen mixtures did not. The data which were obtained with drug-treated and with x-irradiated recipients support the concept that antigen processing by the macrophage is necessary for initiating a primary type immune response. They also demonstrate the selective susceptibility of macrophages and spleen cells to immunosuppressive drugs. (auth)

4581 VIRAL INDUCED IMMUNITY TO SYNGENEIC RAUSCHER MURINE LEUKEMIA CELLS, IN THE ABSENCE OF ALLOGENEIC INHIBITION. **Cohen, Max H.; Fink, Mary Alexander (National Cancer Inst., Bethesda, Md.). Proc. Soc. Exp. Biol. Med., 132: 261-5(Oct. 1969).**

BALB/c mice were immunized with Rauscher murine leukemia virus. Both formalin-treated virulent virus, and a live, attenuated strain of the virus were used as antigens. Immune serums and immune spleen cells harvested 64 days later caused lethal damage to the virus transformed malignant cell. The effectiveness of immune serum was removed by heat inactivation and was restored by the addition of guinea pig complement. Either x irradiation or freezing and thawing eliminated the competence of the immunocytes. Normal spleen cells agglutinated to target cells by phytohemagglutinin were not capable of causing lethal damage to the malignant cells. Although allogeneic inhibition has been suggested as the possible mechanism underlying tumor immunity and surveillance against neoplasia in syngeneic and autochthonous systems, it does not appear to play a significant role in the immunity to transplantation of malignant cells that follows immunization with killed or attenuated murine leukemia virus. (auth)

4582 INDUCTION OF TUMOR-SPECIFIC TRANSPLANTATION IMMUNITY IN HAMSTERS WITH CELL FRACTIONS FROM ADENOVIRUS AND SV40 TUMOR CELLS. **Coggin, J. H.; Elrod, L. H.; Ambrose, K. R.; Anderson, N. G. (Oak Ridge National Lab., Tenn.). Proc. Soc. Exp. Biol. Med., 132: 328-36(Oct. 1969).**

The specific induction of transplantation immunity against adenovirus 31- and SV40-induced hamster tumor cell challenge employing either a crude membrane fraction of homologous adenovirus-31 tumor cells or SV40 tumor cell fragments is described. In each case immunity was equivalent or superior to that induced by whole, x irradiated tumor cells that contain tumor-specific transplantation antigen (TSTA), or to that induced by vaccination of mature hamsters with the live virus. Whole tumor homogenate of adenovirus-31 hamster cells, from which the membrane fraction was obtained failed to induce TSTA immunity. The possibility exists that a masking or enhancing component is present in the homogenate to interfere with TSTA immunity induction or detection. (auth)

4583 CELLS INVOLVED IN THE IMMUNE RESPONSE. VIII. THE RELATIONSHIP BETWEEN THE LOSS AND REAPPEARANCE OF ANTIGEN-REACTIVE CELLS AND IMMUNE RESPONSIVENESS AFTER IRRADIATION OF NORMAL ADULT RABBITS. **Abdou, Nabih I.; Rose, Bram; Richter, Maxwell (Royal Victoria Hospital, Montreal). J. Exp. Med., 130: 867-76(Oct. 1, 1969).**

By appropriate irradiation and cell transfer experiments, a direct correlation was observed between the presence of viable and immunologically active antigen-reactive cells and the capacity of the rabbits to respond following immunization. Rabbits given 800 R ^{60}Co γ total-body irradiation were unable to elicit a humoral immune response nor did they possess significant numbers of antigen-reactive cells. The ability to respond with humoral antibody formation did not reappear until antigen-reactive cells could be detected. These results strongly indicate that the presence of competent antigen-reactive cells are necessary for the successful induction of the humoral immune response in the rabbit. (auth)

4584 INITIATION OF ANTIBODY RESPONSES BY DIFFERENT CLASSES OF LYMPHOCYTES. I. TYPES OF THORACIC DUCT LYMPHOCYTES INVOLVED IN PRIMARY ANTIBODY RESPONSES OF RATS. **Strober, Samuel (National Cancer Inst., Bethesda, Md.). J. Exp. Med., 130: 895-906(Oct. 1, 1969).**

Thoracic duct cells and spleen cells were tested for their ability to restore the primary antibody response of x-irradiated rats to bovine serum albumin (BSA), sheep red blood cells (SRBC), horse spleen ferritin (HSF), and Salmonella typhi flagella. Spleen cells were at least as efficient as thoracic duct cells in restoring the response to BSA, HSF, and Salmonella typhi flagella. In further experiments thoracic duct cells lacking large dividing lymphocytes were tested for their ability to restore the primary response. Large lymphocytes were eliminated by the in vitro incubation of thoracic duct cells for 24 hr at 37°C or by treatment of thoracic duct cell donors with the mitotic inhibitor vinblastine sulfate 24 hr prior to cannulation of the thoracic duct. Experiments with SRBC show that incubated cells and cells from vinblastine-treated donors are as efficient as normal cells in restoring the primary antibody response. On the other hand, experiments with HSF and Salmonella typhi flagella show that incubated cells and cells from vinblastine-treated donors are about five times less efficient than normal cells in restoring the response. Normal thoracic duct cells were more efficient than incubated cells but less efficient than cells from vinblastine-treated donors in restoring the early response to BSA. The experimental findings indicate that the classes of thoracic duct lymphocytes that initiate the primary antibody response to SRBC differ from the classes that initiate the response to HSF and Salmonella typhi flagella, or BSA. (auth)

4585 APPLICATION OF A RADIOIMMUNOASSAY FOR ANGIOTENSIN I TO THE PHYSIOLOGIC MEASUREMENTS OF

PLASMA RENIN ACTIVITY IN NORMAL HUMAN SUBJECTS. Haber, Edgar; Koerner, Theresa; Page, Lot B.; Kliman, Bernard; Purnode, Andre (Harvard Medical School, Boston. Massachusetts General Hospital, Boston. Tufts Univ., Medford, Mass. Newton-Wellesley Hospital, Newton, Mass.). J. Clin. Endocrinol. Metab., 29: 1349-55(Oct. 1969).

A radioimmunoassay for angiotensin I and its application to the determination of renin activity is described. The assay employs antibodies raised to copolymers of angiotensin I and succinylated poly-L-lysine. Angiotensin labeled with ^{125}I and purified by high voltage paper electrophoresis is employed as a tracer. Incubation is carried out in plasma in the presence of 3 metal binding reagents which serve to inhibit effectively proteolytic attack on angiotensin I. Immunoassay of generated angiotensin I is carried out directly on plasma diluted 1 : 20. Fifteen normal volunteers were studied on a metabolic ward at 2 levels of Na intake, during recumbency and upright posture, and following the administration of furosemide. Renin activity increased with Na restriction, was significantly higher on upright activity during both normal and restricted Na intake, and was most markedly elevated following the diuretic. Renin values obtained by immunoassay of angiotensin I correspond closely to those observed by bioassay in similar metabolic studies. The immunoassay provides the advantages of relative simplicity, specificity and reproducibility. (auth)

4586 A NEW IMMUNORADIOACTIVE AGENT: ^{32}P-CONJUGATED ANTIBODY. Spence, R. A.; Swan, J. M.; de Boer, W. G. R. M.; Ghose, T.; Nairn, R. C.; Rolland, Jennifer M.; Ward, H. A.; Wright, S. H. B. (Monash Univ., Melbourne). Clin. Exp. Immunol., 3: 865-72(Oct. 1968).

A radioactive organophosphorus compound, ^{32}P-diphenylphosphinothioic chloride (D^{32}PT chloride) was synthesized from commercially available radioactive phosphorus pentasulfide of high specific activity and conjugated to an immunoglobulin. Goat anti-human-globulin was used and the conjugation had no material effect on its antibody titre. The conjugate was highly radioactive and contained on average twenty-eight phosphorus atoms per globulin molecule. The chemical combination was stable and permitted specific immunodiffusion and immunohistological localization of the antibody as judged by autoradiography. About half of the radioactivity was covalently linked and the rest was probably attached by ionic and/or hydrogen bonds. Highly energetic β-particles only are emitted by ^{32}P and its coupling to antibody should provide a precisely selective immunoradioactive agent for cell and tissue destruction. It might be effective in potentiating anti-lymphocytic sera and, as they become available, anti-cancer sera. (auth)

4587 THE THEORY, PRACTICE, AND TREATMENT OF GRAFT VERSUS HOST REACTIONS. Nouza, K. (Inst. of Experimental Biology and Genetics, Prague). Rev. Fr. Etud. Clin. Biol., 13: 747-62(Oct. 1968).

Generalized and local graft-versus-host reactions are described. Symptoms of secondary disease in individuals restored after lethal irradiation by transplantation of allogeneic bone marrow, spleen lymph node cells, or peripheral leucocytes are discussed. Parabiotic disease in animals connected by coelomic or vascular anastomosis is discussed. The disease produced in F_1 hybrids following transplantation of lymphoid cells of parental origin was used as a model for the graft-versus-host reaction in tolerant recipients. The importance of graft-versus-host reactions in studying immunological problems, such as the genetic basis of immune reactions, detection of potentially immunocompetent cells, and competition of cellular and humoral immunity, is pointed out. The role of autoimmune processes in graft-versus-host reactions is discussed. Effects of graft-versus-host reactions on malignant diseases and adoptive immunotherapy are discussed. Examinations of blood during graft-versus-host reactions reveal anemia, lymphopenia, and eosinophilia. Morphological changes occurring during graft-versus-host reactions include enlargement of lymph nodes, spleen, and liver, degenerative changes in cells, necrosis of the liver, atrophy of lymphoid and hematopoietic tissues, and cachexia. The etiology and pathogenesis of graft-versus-host reactions are discussed. The development of lymphoid aplasia following irradiation in chimeras after administration of an insufficient quantity of bone marrow is discussed. Prevention and therapy of graft-versus-host reactions are discussed with emphasis on immunosuppressive drugs and antilymphocytic serum. (H.L.W.)

Ecology

Refer also to abstracts 4386, 4388, 4542, 4612, and 4633.

4588 (NYO-3364-50) INVESTIGATIONS OF FALLOUT ^{137}Cs IN NORWAY 1962-1967. Stroemme, Aksel (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 84p. Dep. CFSTI.

Data are presented on the content of fallout ^{137}Cs in the environment, in foods, and in man in Norway from 1962 through 1967. The highest concentration of ^{137}Cs in the atmosphere was recorded in 1963, with a gradual decrease thereafter. The deposition of ^{137}Cs on the ground depended on the content of the atmosphere and the amount and type of precipitation. Data are included on the content of ^{137}Cs in meat from cows and sheep, in carrots and potatoes, and in beer and milk during the period studied. The body burden of ^{137}Cs in man was calculated and the possible genetic effects on human populations were evaluated. (C.H.)

4589 (RISO-202) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1968. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1969. 20p. Dep. CFSTI (U. S. Sales Only).

Measurements of fall-out radioactivity in the Faroes in 1968 are presented. Sr-90 (and Cs-137 in most instances) was determined in regularly collected samples of precipitation, grass, milk, fish, bread, and drinking water. In addition, analyses of spot samples of lamb, potatoes, sea water, sea plants, birds, and vegetables were carried out. Estimates of the mean contents of Sr-90 and Cs-137 in the human diet in the Faroes in 1968 are given. (auth)

4590 (UCLA-12-754) PERSISTENCE OF PLUTONIUM IN SOIL, PLANTS, AND SMALL MAMMALS. Romney, E. M.; Mork, H. M.; Larson, K. H. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT(04-1)-Gen-12. 16p. Dep. CFSTI.

A 10-year surveillance was made of the persistence of residual ^{239}Pu in soil, plants and small mammals indigenous to fallout areas contaminated with ^{239}Pu dispersed by high explosive detonations. Downward migration of fallout particles occurred in undisturbed soil profiles, and wind and water erosion accounted for some redistribution of the initial ^{239}Pu contamination. Long-term cropping experiments showed a relatively low degree of ^{239}Pu transfer from soil to plants but a consistent increase in its accumulation in plant tissue during a 5-year cropping sequence. Synthetic chelating agents enhanced plant uptake of ^{239}Pu from soil. The accumulation of residual ^{239}Pu in kangaroo rats and jackrabbits was highest in bone tissue; considerable amounts also were found in lung tissue. High levels found in the gastrointestinal tract indicate that ingestion is a major pathway through which residual ^{239}Pu entered into these small mammals. (auth)

4591 TRANSFER OF SOME RADIONUCLIDES TRAVERSING THE LINKS OF A RIVER FOOD CHAIN. Queirazza, Giulio; Smedile, Elio; Tibaldi, Ettore (Univ., Milan). Atti. Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 46: 81-90(Jan. 1969). (In Italian).

On the basis of examinations of the gut content, a food chain which ends at the predatory ichthyophagous Esox lucius was identified. The results are reported of a comparative gamma-ray spectra study carried out on the ashes of organisms belonging to three trophic levels taken from a stretch of the Po river. The largest number of radioelements under examination (^{65}Zn, ^{60}Co, ^{54}Mn, ^{95}Zr, ^{95}Nb, ^{40}K, ^{134}Cs, ^{137}Cs and ^{90}Sr) were found at a level of the primary producers. A first qualitative reduction was verified in the passage to the primary consumers. A more drastic discrimination was noted in the passage to the secondary consumer Esox lucius. (auth)

4592 EDENTATE ANODONTA COMPLANATA AS INDICATORS OF WATER CONTAMINATION BY CERIUM, RUTHENIUM, AND CESIUM RADIOISOTOPES. Telitchenko, M. M.; Timofeeva, L. A. (Moscow State Univ.). Biol. Nauki, No. 6, 58-61(1969). (In Russian).

The well-known capacity of certain varieties of marine and fresh-water life to accumulate and retain water-contaminating radioisotopes prompted experiments to determine the possibility of using molluscs as indicators of water contamination by ^{144}Ce, ^{137}Cs, and ^{106}Ru. Half-grown Mollusca were gathered from waters in the Moscow area. Solutions of the radioisotopes in the form of chlorides were prepared in the bottom waters of a conduit, poured into two-liter crystallizers, kept for three days, and six of the Mollusca were placed in each of the solutions. Periodically they were removed from the solutions, and separate parts of the body processed to determine their radioisotope content. The experiments definitely proved that Anodonta complanata accumulate and firmly retain ^{144}Ce, ^{137}Cs, and ^{106}Ru in measurable quantities with relative rapidity. A basis is thus provided for recommending their use as indicators of water contamination by the above radioisotopes. (JPRS)

Genetics and Cytogenetics

Refer also to abstracts 4675 and 4678.

4593 (COO-1781-1) REPORT ON RESEARCH PARTICIPATION. Stone, Larrie (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). [1967]. 7p. Dep. CFSTI.

A positive correlation was observed between x-ray induction of chromosomal aberrations and cell lethality in populations of synchronized cells (selected in mitosis) irradiated in different phases of the cell cycle. Cells irradiated in G_1 had less damage than those irradiated near the end of DNA synthesis. Furthermore, similar degrees of radiosensitization were observed for chromosomal aberrations and cell lethality in synchronized cells sensitized prior to synchrony by a pretreatment with BUdR. In addition, the recovery kinetics represented by both the frequency of chromosomal exchanges and cell survival following fractionated doses indicated a significant amount of recovery during a 10 minute period, and both types of recovery occurred during a 90% inhibition of protein synthesis with cyclohexamide. (auth)

4594 (EUR-4249) MOLECULAR AND RADIATION GENETICS. Final Report. (Leiden Rijksuniversiteit (Netherlands)). Feb. 26, 1969. 88p. Dep. CFSTI (U. S. Sales Only).

Research activities of the Laboratories for Physiological Chemistry and Applied Enzymology and Radiobiology of the University of Leiden consisted of radiation effects on in vitro induction of protein synthesis and synthesis of immune substances; radiation effects on structure and function of DNA of animal and bacterial viruses; effects of uv and ionizing radiation on viability, cell division, and mutations in microorganisms; effects of ionizing radiation on DNA; mechanism of action of enzymes and modification by irradiation; and investigations of mutations that modify the biological activity of enzymes. Research activities of the Department of Radiation Genetics consisted of radioinduced mutations in Drosophila; analysis of post-radiation recovery phenomena in mature sperm of Drosophila; effects of oxygen and nitrogen post-treatment on the frequency of mosaics induced by x radiation; cytogenetic analysis of recessive lethals induced in the ring-X chromosome; nucleic acid synthesis during spermatogenesis in Drosophila; radiation effects on gene function, genetic recombination and replication of DNA of bacteriophage; and studies on regulatory mechanisms of somatic cells in vitro. (H.L.W.)

4595 (EUR-4295) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1968. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). 1969. 88p. Dep. CFSTI (U. S. Sales Only).

Results are reported for research projects on the following: mutation breeding; radiation genetics and cytology; radiopreservation of food; radioinduced male sterility in insects; behavior of specific nuclides in plants and soil; radiation protection; and tracer techniques. (auth)

4596 CHANGE IN THE FREQUENCY OF CHROMOSOMAL REARRANGEMENTS IN IRRADIATED PLANTS UNDER THE EFFECT OF GIBBERELLIN. Kryukova, L. M.; Nazarova, L. F. (Inst. of Biological Physics, Pushchino on the Oka, USSR). Dokl. Akad. Nauk SSSR, 187: 453-5(July 11, 1969). (In Russian).

Four-day bean plants (Vicia faba) were given an x-ray dose of 500 R, while 7-day plants were given a ^{137}Cs γ dose of 1000 R. The 4-day plants were placed in a gibberellin solution (25 mg/ml) for 20 hr, and the roots were fixed for cytologic analysis 24, 48, and 78 hours after the irradiation. The percent of chromosomal aberrations at anaphase was 40 to 50% less in plants treated with gibberellin than in untreated plants. The mitotic index was approximately 40% higher in the treated plants than in the untreated plants. The 7-day plants were treated by spraying with a gibberellin solution, and the data obtained for these plants was analogous to the data obtained for the 4-day plants. Thus gibberellin promotes the decrease of chromosomal aberrations, and stimulates cell division, which was sharply repressed by irradiation. (TTT)

4597 INDUCTION OF SOMATIC MUTATIONS IN POTATOES BY GAMMA RADIATION. Vasti, S. M.; Siddiqui, S. H.; Mustafa, G. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). Nucleus (Lahore), 6: 37-42(Jan.-Mar. 1969).

Sprouted potato tubers of seven varieties were given ^{60}Co γ radiation doses ranging from 1.0 kR to 10.0 kR and planted in the field with their respective controls. Changes in skin color and texture, tuber shape, flower color, and aerial tuber formation were observed in VM_1 generation. The Ultimus variety appeared to be more sensitive to radiation among the cultivars used in the experiment. Disease resistance against early blight, developed in mutants of U. S. A. 82 variety in VM_1 generation, was found to persist in VM_2 under field conditions. (auth)

4598 RELATIVE BIOLOGICAL EFFECTIVENESS OF DIFFERENT KINDS OF RADIATIONS ON CHROMOSOME ABERRATIONS IN NIGELLA DAMASCENA SEED. Moutschen, J.; Moutschen-Dahmen, M.; Woodley, R.; Gilot, J. (Brookhaven National Lab., Upton, N. Y.). Int. J. Radiat. Biol., 15: 525-40(1969).

In Nigella damascena the relative biological effectiveness (RBE) of different kinds of radiations was measured for chromosome breaks induced in G_1 and scored at first mitosis after germination of seeds. The effects of γ-rays from ^{137}Cs were used for reference to compute RBE's for 2.8 GeV protons, mono-energetic neutrons, fission neutrons, and α-particles from the reactions $^{10}B(n, \alpha)^7Li$ and $^6Li(n,\alpha)^3H$ following irradiation with thermal neutrons. For 2.8 GeV protons the RBE was 2.1 for total aberrations. The RBE's for mono-energetic neutrons ranged from 44 (1.8 MeV) to 84 (0.43 MeV) for one-break, and 79 (1.8 MeV) to 154 (0.43 MeV) for two-break aberrations: for fission neutrons the RBE was 78 for total aberrations. The low RBE for α-particles from thermal neutron irradiation of seeds enriched with ^{10}B and ^6Li was attributed in part to the non-homogeneous distribution of these atoms in the seeds. (auth)

4599 CHROMOSOMAL ABERRATIONS IN CULTURED LEUKOCYTES FROM PIGS DERIVED FROM X-IRRADIATED SEMEN. Zartman, D. L. (New Mexico State Univ., Las Cruces); Fechheimer, N. S.; Baker, L. N. Contract AT(11-1)-707. Cytogenetics, 8: 355-68(1969).

Semen from swine was x irradiated with 600 R and used to inseminate sows. Chromosomes of the progeny were studied in leukocyte cultures. Of the 31 progeny, 4 had consistent large aberrations in all of the 30 cells studied per animal. Three aberrations were translocations, the other a pericentric inversion. They were attributed to immediate effects of x rays. A mosaic condition seen in 3 of the pigs studied was apparently inherited, at least in 2 of them. All 3 pigs had a breakage-deletion condition for the same chromosome. Among the delayed effects of x irradiation were chromosome alterations which included aneuploidy, fragments, chromosome breaks, chromatid breaks, and chromosome gaps. The independent variables in analyses of variance were x irradiation, breed, sex, irradiation-X-sex interaction and breed-X-sex interaction. Evidently irradiation had a threshold effect, with the effect being a suppression of aberrations. Females, when interacting with the irradiation or breed effects, had higher frequencies of aberrations than males. Breed effects were not consistent, and no trend was apparent. Of the 9 dependent variables studied, only fragments and chromosome breaks were noticeably correlated. (BBB)

4600 A NEW KIND OF FERTILITY VARIANT IN STREPTOMYCES COELICOLOR. Hopwood, David A.; Harold, Richard J.; Vivian, Alan; Ferguson, Helen M. (Univ. of Glasgow. John Innes Inst., Norwich, Eng.). Genetics, 62: 461-77(July 1969).

The isolation of "ultrafertile" (UF) variants from N-methyl-N'-nitro-N-nitrosoquanidine-treated, uv-irradiated, or untreated Streptomyces coelicolor A3(2) is described. The spores produced on a mixed colony of a UF strain and a strain with normal fertility (NF) were almost exclusively sexually produced. These crosses were "polarized," i.e., the UF strain contributed a complete (or almost complete) genome to all zygotes and the NF strain contributed only a chromosome fragment. All haploid progeny arising from these zygotes derived a region of their genome, between uraA and nicA, from the NF parent. (MMB)

4601 EFFECTS OF ULTRAVIOLET IRRADIATION ON HETEROZYGOUS DIPLOIDS OF ASPERGILLUS NIDULANS. I. UV-INDUCED MITOTIC CROSSING OVER. Wood, Stephen; Kaefer, Etta (McGill Univ., Montreal). Genetics, 62: 507-18(July 1969).

Quiescent and germinating conidia of three Aspergillus diploids heterozygous for color and other mutants were irradiated with uv light. Increased color segregation in normally viable colonies was slight for quiescent but drastic for germinating conidia. These segregants were attributed to uv-induced mitotic crossing over since reciprocal products, or twin spots, were frequently identified. Nutritional markers segregated with an identical frequency in colonies with or without color sectors, indicating that coincident crossing over in different chromosome arms was random. Consequently the frequency of uv-induced homozygosis for any marker can be used as a measure of the "mitotic" distance between that marker and its centromere. Instances of coincident reciprocal mitotic crossing over have been found to occur both in the same division and in two consecutive divisions. (auth)

4602 GENETIC CONTROL OF RADIATION SENSITIVITY IN SACCHAROMYCES CEREVISIAE. Resnick, Michael A. (Univ. of California, Berkeley). Genetics, 62: 519-31(July 1969).

Eight mutants of genes that control radiation sensitivity in Saccharomyces cerevisiae have been isolated after nitrous acid treatment. Three are sensitive to UV (uvs 9−2, 9−3, and uvs 1−2), one is sensitive to UV and X rays (uxs 1), and four are X ray sensitive (xs 1, xs 2−1, 2−2, xs 3). The uvs 1 gene is 19.5 centimorgans from the centromere of chromosome XVI and uvs 9 is 23 centimorgans from the centromere of a newly identified chromosome XVII. (auth)

4603 INDUCED MUTATION IN PHAGE ΦX174 AFTER UV-IRRADIATION OF HOST BACTERIA. Likhacheva, N. A.; Zavil'gel'skyii, G. B. (Gamalian Inst. of Epidemiology and Microbiology, Moscow. Inst. of Molecular Biology, Moscow. Genetika; 5: No. 10, 119-26(Oct. 1969). (In Russian).

Investigation was made of phage ΦX174 amber mutant reversions to the wild type after uv irradiation (254 nm), O-methylhydroxylamine (O-MHA) and photodynamic action (acriflavin + visible light). Ultraviolet irradiation and photodynamic action produce slight mutagenic effect in phage adsorbed on non-irradiated bacteria, while O-MHA did not induce phase reversions at all. The mutagenic effect increased 10 to 100-fold, when irradiated or O-MHA-treated phage was absorbed on irradiated bacteria hcr$^+$. Under the same conditions, photodynamic action enhanced reversions 10-fold, while irradiated bacteria lacked this effect. It was suggested that hcr-enzymes take part in mutations, which are primarily induced in phage DNA under uv irradiation, O-MHA, and photodynamic action. (auth)

4604 FRACTIONAL AND COMPLETE MUTATIONS INDUCED BY X-RAYS IN SPERMS, SPERMATIDS, AND SPERMATOCYTES OF DROSOPHILA. Abeleva, E. A.; Poekhina, N. A. (Inst. of Developmental Biology, Moscow). Genetika; 5: No. 10, 44-9(Oct 1969). (In Russian).

The mutation process induced by x rays (1500 R) at different stages of spermatogenesis in Drosophila was studied. The yield of fractional and complete sex-linked lethals and semilethals was recorded. The distribution pattern of frequencies of mutants in the progeny of the F_1 mosaic females was also analyzed. The frequency of fractional semilethals was very close to that of complete lethals and semilethals. The yield of fractional semilethals, as well as of complete lethals and semilethals was significantly higher in spermatids and spermatocytes, than in sperm. The incidence of the fractional lethals was much lower than that of other mutations and was similar at different stages of spermatogenesis. The distribution of the frequency of fractional lethals in the progeny of the F_1 mosaic females differed significantly from that of fractional semilethals. The above data suggest that different mechanisms are involved in the production of these mutations. The analysis of distributions supports the view that fractional lethals are mainly the result of the delayed action of the mutagene, while fractional semilethals are the consequence of the potential alterations. Distributions were similar in character for all the stages of spermatogenesis. Only quantitative differences were observed. (auth)

4605 THE MUTAGENIC EFFECT OF DIFFERENT TYPES OF RADIATIONS ON THE GERM CELLS OF MALE MICE. III. THE GENETIC EFFECTS OF THE X-RAY TREATMENT OF SPERMATOGONIA ON THE FIRST GENERATION OF THE DESCENDANTS OF TREATED MALES. Pomerantseva, M. D. (Inst. of General Genetics, Moscow). Genetika; 5: No. 10, 30-7(Oct 1969). (In Russian).

Genetic damage in the first generation of the progeny of males subjected to irradiation of spermatogonia with intermediate neutrons (16, 32, and 64 rad doses) and with x rays (a single 600 R × 3 fractionated dose, administered at 28-day intervals) was studied. Among the 483 males of the first generation 4 proved to be heterozygous for reciprocal translocations. The difference between the observed frequency of translocations and that estimated theoretically on the basis of a cytological analysis was not statistically significant. As it was shown by a study on the mortality of younglings before weaning, only in one variant of the experiment (600 R dose of x rays) the death-rate was higher than in the control. Neither the rate of survival of the embryos, nor the post-implantation death-rate in the second generation exhibited any difference from the control. The radioresistance of the first-generation individuals also did not differ from that in the control. On the basis of these results, as well as of the data published by other authors, the existence of a selective elimination of genetic damage not only at spermatogonial stages, but also at later stages of spermatogenesis can be assumed. (auth)

4606 EFFECT OF POST-IRRADIATION CENTRIFUGATION ON CHROMOSOME ABERRATIONS IN VICIA FABA. Jakob, Karl M. (Weizmann Inst. of Science, Rehovoth, Israel); Wolff, Sheldon. Int. J. Radiat. Biol., 15: 519-23(1969).

Vicia faba primary roots were x-irradiated in air from 0 to 700 R and immediately centrifuged for 20 min (2500g) at room temperature. Metaphase analysis of chromosome aberrations showed that with centrifugation there are: a small but consistent increase in chromosome exchanges (two-break aberrations); no significant difference between the centrifugation enhancement ratios for exchanges at the various x-ray doses of the dose-response curves; no increase in terminal deletions (one-break aberrations); no consistent increase in interstitial deletions (ID). The results are consistent with the hypothesis that this post-irradiation treatment increased the number of sites in the interphase nucleus where chromosomes are close enough to exchange if broken by x-rays. (auth)

4607 KINETICS OF TWO-BREAK ABERRATION PRODUCTION BY X RAYS IN HUMAN LEUKOCYTES. **Bender, M. A.; Barcinski, M. A. (Oak Ridge National Lab., Tenn.). Cytogenetics, 8: 241-6(1969).**

An attempt was made to confirm the linear dose-effect kinetics reported previously for the production of 2-break aberrations in x-irradiated human leukocyte cultures fixed after 52 to 56 hr incubation. Six-hr blood leukocyte cultures were given exposures of 50, 100, 150, 200, or 250 R, at a rate of 50 R/min, of 250-kV x rays. Least-squares regression analyses were done to determine the best fits of the deletion and of the ring and dicentric data to the linear ($Y = a + bD$, where Y is the yield, a the spontaneous frequency, D the dose, and b the coefficient of aberration production) and the dose-square ($Y = a + bD^2$) models. The dose-square model was rejected for lack of fit for the deletion data, as was the linear model for rings and dicentrics. The best-fit coefficients of aberration production were: $b = 2.48 \pm 0.12 \times 10^{-3}$ deletions per cell per R, and $b = 12.74 \pm 0.15 \times 10^{-6}$ rings and dicentrics per cell per R^2. Although noninteger values of n for the model $Y = bD^n$ are inappropriate for classical target theory, the best-fit values of n were also calculated as a further test of whether the dose-effect kinetics were linear or dose-square. For deletions, this value was $n = 1.10 \pm 0.08$; for rings and dicentrics, $n = 2.15 \pm 0.07$. Evans obtained a best-fit estimate of n for ring and dicentric production of $n = 1.17 \pm 0.04$; the P value for "goodness of fit" for the pooled data was 0.22 and the P value for a t test for $n = 1$ was $\ll 0.001$. This is contrasted with present values of $n = 2.15 \pm 0.07$ and a P for a test of the possibility that $n = 1$ of < 0.01. Thus, Evans' results were not confirmed in spite of a careful attempt to duplicate his experimental conditions. On the other hand, the results agree well with other workers' results. (BBB)

4608 MULTIPLE-STEP RECOVERY FROM HERITABLE LETHAL SECTORING IN YEAST. **James, A. P.; Werner, Mary M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Genetics, 62: 533-41(July 1969).** (AECL-3410).

Recovery from heritable lethal sectoring was studied in two unstable strains of diploid yeast. The instability of one of these strains was x-ray-induced, that of the other was of spontaneous origin. Unstable cells were characterized by a reduced rate of cell division and by the frequent production of normal revertant cells, as well as by the production of abortive sublines (lethal sectors). Recovery was found to be a multi-step process since more closely related cells tended to be more alike in propensity for full recovery than less closely related cells. Partial recovery, as a result of which cells became more disposed to full recovery, was expressed as a reduction in the observed frequency of lethal sectoring. (auth)

4609 A 39, X/41, XYY MOSAIC MOUSE. **Evans, E. P.; Ford, C. E.; Searle, A. G. (Medical Research Council, Harwell, Eng.). Cytogenetics, 8: 87-96(1969).**

An account is given of an XO/XYY mosaic male mouse identified in the course of an irradiation experiment. Male mice were given 600 + 600 rad acute x irradiation to the hind quarters (including the testes), and sons sired in the post-sterility period were tested for fertility by caging each at maturity with normal females. Four of the sons had not made any mate pregnant after 6 weeks. They were judged to be sterile, killed, and the testes were removed for meiotic preparations. Three showed normal spermatogenesis. The fourth sterile male had a normal appearance when killed at the age of 18 weeks, but only a single, small, yellowish testis was found. Spermatocytes with an extra small univalent chromosome were seen. This sterile mouse was found to be a chromosomal mosaic with 2 cell lines, 1 containing 39 chromosomes, the other 41. Both types were present in approximately equal numbers in the bone marrow, but the 41-chromosome line alone was identified in spermatogonia and spermatocytes. Evidence from chromosome morphology at mitotic metaphase and from spermatocytes at diakinesis and metaphase I identified the 2 cell lines as XO and XYY respectively. The alternative possibilities of exclusion of the XO line from the seminiferous elements by chance and by selection are discussed and the latter interpretation favored. The Y chromosome of mammals may carry genetic information essential for normal spermatogenesis, as distinct from its established function in embryonic gonadal determination. (BBB)

Health Physics and Safety

Refer also to abstracts 4512 and 4513.

Radioactive Contamination and Decontamination

Refer also to abstracts 4588, 4589, 4591, and 4592.

4610 THE OUTWARD RADIOCONTAMINATION OF MEAT PRODUCTS. 2. INVESTIGATION OF CONTAMINABILITY OF MEAT PRODUCTS AT DIFFERENT PHASES OF TECHNOLOGICAL PROCESSING. Stankovic, Slobodanka; Petrovic, B.; Raseta, J. (Inst. for Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Belgrade). Acta Vet. (Belgrade); 18: 215-18(1969). (In Slovak).

Effects of fission radioisotopes on meat products were investigated. Within 1 hr, the outer parts of the meat were contaminated while the core was relatively normal. (H.B.G.)

4611 THE USE OF COMPLEXING AGENTS AS PROTECTIVES IN THE CONTAMINATION OF ORGANIC MEMBRANES. Stankovic, Slobodanka; Veljkovic, Slobodanka (Inst. for Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Acta Vet. (Belgrade); 18: 203-13(1969). (In Slovak).

The adsorption of the radioactive ions: $^{137}Cs^{+1}$, $^{85}Sr^{+2}$, $^{89}Sr^{+2}$, $^{144}Ce^{+3}$, and ^{59}Fe (ferric citrate) on the surface of cellulose and polyethylene membranes and their penetration were studied with the aim of protecting food from radioactive contamination. These membranes served as casings for meat and meat products. The results obtained by radiometric measurements showed that the penetration and the adsorption of ions decreased considerably after radionuclide complexing with the organic acids: ethylendiaminetetraacetic acid (disodium salt), benzoic acid (sodium salt), citric, lactic, and ascorbic acids. These organically complexed ions showed modified properties for adsorption, while the penetration of ions depended on the size of the complex formed and the size of the membrane pore. The possibility of the impregnation of membranes with organic acids may be considered as a protective measure to reduce the radioactive contamination of foods. (auth)

4612 IMPORTANCE OF SOME METHODS OF PASTURE FEEDING, OF PASTURE TYPE, AND OF SEASONAL FACTORS ON ^{85}Sr AND ^{134}Cs TRANSFER FROM GRASS TO MILK. Van den Hoek, J. (Agricultural Univ., Wageningen, Netherlands); Kirchmann, R. J.; Colard, J.; Sprietsma, J. E. Health Phys.; 17: 691-700(1969).

The activity of ^{85}Sr and ^{134}Cs was investigated in the milk of three groups of cows after deposition of the radionuclides on pasture under field conditions by a spraying technique at four different moments of the grazing season. The animals were kept according to three different methods of feeding: green soiling, rotational grazing and free grazing. ^{85}Sr milk levels were found to be significantly lower in the free grazing group which also showed the greatest variations in ^{134}Cs milk levels. No differences in milk activity could be demonstrated according to whether the cows grazed on an old permanent or a newly sown, temporary pasture. A highly significant seasonal effect on ^{134}Cs levels in milk was seen to occur in all groups, their milk activity increasing by a factor of about 1.5 to 3 for the late summer experiments whereas ^{85}Sr levels remained fairly constant. This different behavior of the two radionuclides could be explained for the animals of the green soiling group by changes in transfer coefficient and variations in ingested radioactivity. The transfer coefficient from grass to milk was determined in the green soiling group. It ranged from 0.31 to 0.45% for ^{134}Cs and from 0.05 to 0.07% for ^{85}Sr, the lowest transfer of ^{134}Cs and the highest of ^{85}Sr being recorded at the beginning of the grazing seasons. The importance of some factors which might have influenced milk activity in the other groups, is discussed. (auth) (UK)

4613 EVALUATION OF A ^{203}Hg EXPOSURE. Scott, L. M. (Union Carbide Corp., Oak Ridge, Tenn.). Contract W-7405-Eng-26. Radiology, 93: 338(Aug. 1969).

It was established that a new employee had an internal deposit of ^{203}Hg from a routine in vivo radiation measurement. He had previously been employed in the radiopharmaceutical industry and had worked with ^{203}Hg. A series of five measurements were made in vivo, taking counts over head, back, hips, and thighs in relation to the count rate over the kidney. The data obtained reaffirmed that mercury was deposited preferentially in the kidney. It was concluded from these data and those previously reported that there is probably a longer effective half-life for ^{203}Hg than that assumed by ICRP. (C.O.)

4614 THE OUTWARD RADIOCONTAMINATION OF MEAT PRODUCTS. 3. INVESTIGATION OF CONTAMINABILITY OF SOME DRY MEAT PRODUCTS. Stankovic, Slobodanka; Petrovic, B.; Raseta, J. (Inst. for Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Belgrade). Acta Vet. (Belgrade); 18: 219-22(1969). (In Slovak).

Fission products were studied as to their effects on meat products. It was concluded that after fallout exposure meat should not be used for human consumption, unless the outer layer, about 1 cm in thickness, is removed. (H.B.G.)

4615 OSSEOUS DEPOSITION OF RADIOSTRONTIUM IN CATTLE OF VARIOUS AGES. REPORT II. Lanzola, E.; Simonetti, A. D'Arca; Del Vecchio, R. (Univ., Rome). Nuovi Ann. Ig. Microbiol., 17: 245-51(July-Aug. 1966). (In Italian).

Concentrations of ^{90}Sr in the bones of 5 cattle (aged 5 months to 10 years) of the Marchigiano breed were measured in November 1964. Results were compared with those for earlier years (1960 to 1963). The ^{90}Sr concentrations in the cattle bone at age 10 years were relatively low, cattle aged 4 yr, 20, 8, and 5 months had progressively higher levels. In those of 5 months old, an average value was reached of 56 pCi/g Ca. This is due to the more intense fallout which followed the atomic explosions of 1962 and 1963. The ^{90}Sr found in animals butchered in 1964 was higher than that found in the corresponding series butchered in 1962 (except for the 10-yr-old group). (BBB)

Dosimetry and Monitoring

Refer also to abstracts 4232, 4247, 4424, 4514, 4515, 4620, 4637, and 4651.

4616 (BNL-14154) TRANSIT DOSE AND SOURCE UNIFORMITY IN A ^{90}Sr-^{90}Y BLOOD IRRADIATOR. Rothbart, M. A.; Davis, C. R.; Muller, A. C.; Hill, F. B. (Brookhaven National Lab., Upton, N. Y.). Sep 1969. 26p. (CONF-690508-3). Dep. CFSTI.

From Conference on Radiation and Isotope Technology in Latin American Development, San Juan, Puerto Rico.

A technique is described for measuring the transit dose in portable β irradiators for extracorporeal irradiation of blood and lymph. Methods are described for estimating the degree of nonuniformity in the source in the flow direction, and in the radial dose rate distribution. The results of applying these techniques to a small prototype irradiator having a ^{90}Sr β source are given. Schematic sketches are included of the irradiator, the Fricke dosimeter (a ferrous ammonium sulfate solution used as the flowing medium) used to measure absorbed dose, and the silicon solar cell used to measure the uniformity of the distribution of ^{90}Sr along the length of the source. (C.H.)

4617 (BNWL-1159) DOSIMETRY TECHNOLOGY STUDIES ANNUAL REPORT, 1968. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1969. Contract AT(45-1)-1830. 69p. Dep. CFSTI.

Separate abstracts were prepared for the six papers presented. (W.H.K.)

For abstracts of individual papers see: 4461, 4495, 4496, 4547, 4618, and 4619.

4618 (BNWL-1159, pp 1-2) ACTIVATION OF BODY SODIUM FOLLOWING LOW NEUTRON EXPOSURES. McConnon, D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Sodium-24 content in the body from the activation reaction $^{23}Na(n,\gamma)^{24}Na$ was measured for estimating neutron doses to five reactor personnel. A scintillation whole-body counter was used and results are presented. (W.H.K.)

4619 (BNWL-1159, pp 3-6) DETERMINATION OF DOSE DISTRIBUTION FOLLOWING NON-UNIFORM EXPOSURE TO A CRITICAL ASSEMBLY. McConnon, D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Results of a study to determine the prospects of estimating neutron dose to personnel by measuring activated calcium-49 are presented. A phantom filled with a tissue-equivalent solution and containing a full skeleton was irradiated with neutrons, and the calcium-49 content from $^{48}Ca(n,\gamma)^{49}Ca$ reactions was measured. (W.H.K.)

4620 (CONF-691016-1) PRELIMINARY DOSIMETRY DATA ASSOCIATED WITH RADIOISOTOPE CISTERNOGRAPHY. Johnston, R. E.; Staab, E. V.; Allen, J. H.; Brill, A. B. [nd]. 15p. Dep. CFSTI.

From 10th Annual Meeting Southeastern Chapter Society of Nuclear Medicine, Nashville, Tenn.

The preliminary results of an investigation of the radiation dose to the spinal cord during radioisotope cisternography are given. Following the injection of 100 μCi of ^{131}I-serum albumin (RISA), with a concentration of about 500 μCi/ml, into the lumbar subarachnoid space, serial scans, thyroid uptake measurements, blood samples, urine collections, whole-body counts, and profile scans of the spinal cord were obtained to determine the movement and activity of the injected RISA. In general, the patients studied could be grouped into one of three groups; those injected into the subarachnoid space and demonstrating a normal cerebral spinal fluid (CSF) flow, those injected into the subarachnoid space and demonstrating an abnormal CSF flow, and those injected into the extra-arachnoid space. The latter group occurred less frequently as techniques improved. The dosimetric parameters for the three groups derived from the variety of data collected are given. (E.R.B.)

4621 (ORNL-TM-2730) NEUROSPORA EXPERIMENT P-1037. Quarterly Progress Report to the National Aeronautics and Space Administration, July 1–September 30, 1968. de Serres, Frederick J.; Webber, Brooke B. (Oak Ridge National Lab., Tenn.). Nov. 1969. 52p. Dep. CFSTI.

The development and use of passive dosimetry systems are described. Correction factors for the following are discussed: EG&G calcium fluoride dosimeters; EG&G lithium fluoride dosimeters; ConRad lithium fluoride teflon disk dosimeters; and over response to scattered low-energy radiation. The care and handling of dosimeters are discussed. Tables and graphs are presented to show results of dosimetric analyses in the three post-flight tests and in those pre-flight tests for which calibrated dosimeters were used. (H.L.W.)

4622 (SC-DC-68-2229) STUDIES IN RADIATION RISK CRITERIA FOR SNAP SYSTEMS. Everett, R. J.; Parsont, M. A. (Sandia Labs., Albuquerque, N. Mex.). May 1968. 13p. (CONF-680503-7). Dep. CFSTI.

From American Industrial Hygiene Conference, St. Louis, Mo.

Based on currently available information, a radiation risk criterion of 0.01 fatality, or 750 man-rem, per launch of SNAP systems is suggested as acceptable in light of normally incurred risks. (auth)

4623 THE DOSIMETRY OF IRRADIATIONS OF CHLAMYDOMONAS CELLS WITH HIGH LET RADIATIONS FROM A VAN DE GRAAFF ACCELERATOR. Holt, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Med. Biol.; 14: 563-72(Oct 1969).

Physical aspects are described of the use of a van de Graaff accelerator for the irradiation of Chlamydomonas Reinhardtii cells with mono-energetic protons, deuterons and α-particles having LET's in the range 100 to 1300 MeV g^{-1} cm^2. The beam was monitored by an ionization chamber, and a dc to pulse-rate converter enabled accurate doses to be delivered; formulae are derived relating the dose in the cells to the current from a guarded field ionization chamber used to calibrate the monitor chamber. A silicon diode was used to measure the particle energy spectrum. (auth) (UK)

4624 RELATIVE IMPORTANCE OF LEAKAGE AND SCATTER IN MEGAVOLTAGE INSTALLATION DESIGN. McEwan, A. C. (Cambridge Univ., Eng.). Phys. Med. Biol.; 14: 659-60(Oct 1969).

Measurements, on a ^{60}Co teletherapy unit and a 14 MV linear accelerator, of the leakage and scatter radiation were made using an ionization chamber over a range of angles on a Predswood phantom. The scatter for the accelerator was found to be negligible compared to the leakage from the point of view of shielding design. (UK)

4625 THREE-DIMENSIONAL DOSE DISTRIBUTION IN ^{60}Co TELETHERAPY OF THE HEAD AND NECK. Mansfield, Carl M.; Galkin, Benjamin M.; Suntharalingam, N.; Chow, Michael C. (Thomas Jefferson Univ., Hospital, Philadelphia). Radiology, 93: 401-4(Aug. 1969).

Measurements of three-dimensional dose distributions in the head and neck sections of an Alderson-Rando phantom have been made by means of thermoluminescent dosimetry. Cobalt-60 treatment techniques were selected to simulate actual clinical situations, and the resulting dose distributions have been compared. The value of three-dimensional dose measurements in clinical practice has been discussed. (auth)

4626 PRELIMINARY MEASUREMENTS OF ELECTROMAGNETIC RADIATION FIELDS NEAR MICROWAVE OVENS. Solem, D. L.; Remark, D. G.; Moore, R. L.; Crawford, R. E.; Rechen, H. J. L. (Dept. of Health, Washington, D. C.). Non-Ioniz. Radiat.; 1: 88-94(Sep 1969).

Microwave ovens from five different manufacturers were tested in an anechoic microwave chamber to find the electromagnetic radiation exposures encountered if safety devices failed. Power densities of greater than 700mW/cm^2 were found 30cm in front of an oven with the door open, and power densities of 10mW/cm^2 at 120cm from the ovens. Safety interlock switches were examined to find how they operated and how they could be defeated. In all cases except one operation of safety interlocks relied solely on spring powered switches to prevent the generation of microwaves when the doors were opened. In one case a safety interlock used the operation of the door latch to inactivate the microwave generation system. In another it was possible to manipulate the interlock system without tools to permit generation of microwave power with the door open. The response of three commercially-available microwave power measuring instruments was compared in the microwave field produced by an oven. Near field maxima and minima did not coincide either in amplitude or location, and far-field measurements of power density agreed only to within a factor of 12 (10.8dB) among the different instruments. Failure of the door microwave energy seal was simulated for each oven, and the resulting microwave radiation leakage observed. (auth) (UK)

4627 SEQUENTIAL STATISTICS APPLIED TO RADIATION MEASUREMENT. Blincoe, Clifton (Univ. of Nevada, Reno). Health Phys.; 17: 679-84(1969).

Sequential analysis is a method of statistical inference in which the number of observations is not determined in advance of the experiment. This statistical method has been applied to radiation measurement. The case considered was that of determining if a preset limit was exceeded or fallen short of. Sequential procedures were compared with the conventional statistical procedure for counting and found to be more efficient in the time required to decide if a limit was exceeded or fallen short of. (auth) (UK)

4628 EVALUATION OF THE FRICKE DOSIMETER WITH OTHER DOSIMETRY SYSTEMS. Oller, William L.; Menker, Donald F.; Dauer, Maxwell (Univ. of Miami, Fla.). Health Phys.; 17: 653-9(1969).

The characteristics, preparation, and data necessary for the measurement of ionizing radiation by the application of a ferrous ferric chemical dosimeter are given. Dose range, dose rate dependence, energy dependence, and temperature effects are discussed. Three different methods for the measurement of ferric ion concentration are described. A table of extinction coefficients for the ferrous ferric chemical dosimeter is included. A comparison of lithium fluoride dosimetry, commercial film badge dosimetry, Landsverk ion chamber dosimetry, and ferrous ferric chemical dosimetry for the measurement of ^{60}Co γ radiation are included in tabular form. (auth) (UK)

4629 THE INFLUENCE OF THE CURVED SURFACE ON THE DECREMENT LINES FOR TELECOBALT-BEAMS. Debois, J. M. (Department de Radiotherapie et Radioisotopes Clinique St-Norbertus, Duffel, Belgium). J. Belge Radiol., 52: 140-2(1969).

With the aid of the decrement lines system, the total penumbra was measured below curved surfaces. The penumbra is reduced below convex surfaces but enlarged below concave surfaces. This is in accordance with theory. (auth)

4630 CALCULATION OF ACCUMULATED ABSORBED DOSE TO THE THYROID CELL DURING UPTAKE OF ^{131}I. Ueno, Yori; Torizuka, Kanji (Kyoto Univ.). Kaku Igaku, 5: No. 2, 142-5(July 1968). (In Japanese).

Calculation to estimate the accumulated absorbed dose in the thyroid gland cell at a given time after the administration of substances containing ^{131}I was performed under several conditions. The comparison of radiation injuries to the thyroid gland cell in clinical studies and in experiments with internal or external irradiation under the condition of the same accumulated absorbed dose was possible using this method. The method of calculation was discussed. (auth) (TSS)

4631 DATA PROCESSING FOR DOSE CALCULATION IN TELECOBALT THERAPY. Leetz, H.-K. (Univ., Homburg, Ger.). Medicamundi, 14: 90-6(1969).

To obtain full and optimal benefit from the great flexibility of movement provided by the radiation source of a cobalt-60 therapy unit and consequently from the possibility of varying the dose distribution in the object, it is necessary to employ a digital computer. This is all the more essential since the required calculations and the resulting corrections in the treatment plan have to be effected within narrow time limits. A procedure is described, in which attention is given to the determination of the dose distribution and the working out of a treatment plan. (auth)

Radiation Protection

Refer also to abstract 5195.

4632 (ARH-220) RADIATION PROTECTION STANDARD. (Atlantic Richfield Hanford Co., Richland, Wash.). Sept. 15, 1969. Contract AT(45-1)-2130. 48p. Dep. CFSTI.

The Radiation Protection Standards and Controls set forth in this manual describe the methods of controlling radiation exposure to employees and the public. Atlantic Richfield Hanford Company is contractually obligated to take all reasonable precautions to protect the health and safety of employees and the public and to minimize danger to life and property from all radiation and radioactive material under its control. The requirements necessary to safely control radiation are stated as Radiation Protection Standards. Compliance with these standards is mandatory. The standards provide information regarding contractual requirements set forth by the United States Government as administered by the U. S. Atomic Energy Commission, Contract AT(45-1)-2130. In addition, the guides include published recommendations of authoritative national and international bodies as well as instructions and guides written by the Richland Office of the AEC and other Hanford contractors. The standards are based on the knowledge and the special capabilities available at Hanford. The standards state the requirements for radiation protection within the company and are written to provide a uniform and purposeful method of compliance. Where the standards are not directly applicable, additional guidance should be obtained through consultation with the Personnel Protection Section. The interpretation of the Radiation Protection Standards and Controls is the responsibility of the Personnel Protection Section. (auth)

4633 (N-69-34910) KSC SNAP-27 RADIOLOGICAL CONTROL PLAN. (Tracerlab, Richmond, Calif.). Sept. 1968. Contract NAS10-5320. 138p. (NASA-CR-104121; TLW-6023). CFSTI.

The SNAP-27 radioisotope-fueled thermoelectric power system will provide the electrical power for the Apollo Lunar Surface Experimental Packages that are to be placed on the moon by the astronauts. The ^{238}Pu fuel for the SNAP-27 will be transported in a separate cask mounted on the Lunar Module. This radiological control plan is intended to: provide detailed procedures to ensure that there is no unnecessary exposure or contamination of workers, the general public, or the biosphere during a nominal mission; provide detailed procedures to cope with all conceivable accidents or incidents quickly and with minimal hazard to operating personnel; and fulfill and exceed the minimum radiological safety criterial specified for the SNAP program. The period of concern is from the receipt of the fuel at KSC to orbital insertion. Environmental data from the period before the actual receipt of the fuel is also necessary to make sound operational decisions based on data comparison. (auth) (STAR)

4634 STANDARD ROENTGEN EXAMINATIONS IN NEWBORNS, INFANTS, AND CHILDREN: TECHNIQUES, PORTABLE FILMS, IMMOBILIZATION DEVICES, AND FLUOROSCOPY. Davis, Lawrence A. (Univ. of Louisville Medical School, Ky.). Progr. Pediat. Radiol., 1: 3-17(1967).

Ways of protecting infants and children from excessive exposure in x-ray and fluoroscopic diagnosis are presented. In chest radiography in infants, since there is no need for the gonadal area to be directly exposed, a large piece of thick lead rubber is laid across the lower abdomen and pelvis. Proper coning of the beam is also required, but the lead shield is double protection against direct gonadal irradiation. In the older child upright films can be obtained in the standard manner but, again, lead rubber shielding is essential. Web strapping with the shielding attached with an adjustable buckle may be an integral part of the upright film stand. The use of high-kV techniques with relative lowering of the ma-sec values decreases the radiation dose to the patient. Modern x-ray generators of the 3-phase type are highly desirable in pediatric radiography. First, the minimum exposure time is shorter than with conventional single-phase equipment, a necessity in stopping motion. Second, the continuous image-forming radiation in the 3-phase apparatus has a low percentage of soft radiation. The latter, produced in greater quantities in conventional equipment, is ineffectual in image production and raises the radiation dose to the patient. (BBB)

Safety Procedures

Refer also to abstracts 4547, 4622, and 5365.

4635 (N-69-35968) SKIN LESION THRESHOLD VALUES FOR LASER RADIATION AS COMPARED WITH SAFETY STANDARDS. Final Report. Paar, Wordie H. (Army Medical Research Lab., Fort Knox, Ky.). Feb. 24, 1969. 15p. (AD-688871; USAMRL-813). CFSTI.

The large amount of skin surface makes this body tissue readily available to accidental and repeated exposures of laser radiation, and most laser safety programs include minimal radiation levels for skin exposure. However, the values suggested are generally those considered non-hazardous under worst case conditions and are not based on experimental evidence. This report briefly summarizes the few studies found in the open literature that might be considered pertinent towards establishing acceptable acute laser radiation levels for skin. The threshold lesion values given for both human and animal skin are discussed and compared with guideline values suggested for safe exposure levels. (auth) (TAB)

4636 AVERAGE AGE AT DEATH OF SCIENTISTS IN VARIOUS SPECIALTIES. Luria, S. M. (Naval Submarine Medical Center, Groton, Conn.). Public Health Rep. (U. S.), 84: 661-4 (July 1969).

A survey of longevity of scientists revealed that those in radiation specialties had the lowest life span of the population sampled. An analysis was made of the deaths reported in Science from January 1958 through January 1968. The death notices were categorized by sex and major field of concentration. Archeologists had the highest average age at death (76.7 yr) while administrators and men working with some form of radiation had the lowest average age at death (61.8 yr in both categories). The difference between these extreme means was nearly 15 yr, which was larger than the standard deviations associated with these means. The mean age at death for the entire sample of 2224 men was 67.7 yr. Although there were few women in any given category, every specialty is represented except pharmacy. Despite the low correlation obtained between the rankings for men and women, the mean age at death for the 3 women who held administrative positions was 59.3; the one woman cited as having worked in a radiation laboratory died at 42. Thus, there seem to be sizable differences in the average longevity of the men in different scientific specialties whose deaths were reported in Science. The low average longevity of physicists (64.4 yr) may be the result of the inclusion of a large proportion of men working with radiation. (BBB)

4637 CHECKING DOSAGES RECEIVED BY WORKERS EXPOSED TO IONIZING RADIATION. Cerovac, H. Arh. Hig. Rada Toksikol., 19: Suppl. No. 1, 41-7(1968).

Possible methods of testing the efficacy of radiation protection measures are considered. Data compiled by an institute responsible for checking film badges of workers exposed to ionizing radiation are discussed. Tables are presented giving the results of dosimetric checkups on 2000 Croatian workers during the period 1962 to 1967. (Occup. Safety and Health Abstr.)

Legal Aspects

Refer also to abstract 4709.

4638 (COO-1826-4) URANIUM MINERS HEALTH. Saccomanno, Geno (Saint Mary's Hospital, Grand Junction, Colo.). Nov. 20, 1968. 13p. Dep. CFSTI.

There is little evidence available from present data to indicate that a 1 to 3 WL (working level) is injurious to health. No evidence is available to indicate the WLM (working level month) accumulated at these low levels causes cancer of the lung, and therefore the 1 WL should not be lowered. There is evidence available that the predicted number of cancer of the lung, based on the thesis that 5,000 WLM would yield one cancer of the lung, is in error. It is believed that cigarette smoking and radon daughters synergistically cause cancer of the lung. Since radon and radon daughters are short lived, it would seem that cigarette smoking should be banned while miners are underground mining uranium. (auth)

4639 DUTY OF NUCLEAR RESPONSIBILITY AND SECURITY CONSIDERED ACCORDING TO THEIR EFFECTS ON RADIOPROTECTION. Hebert, J. (Electricite de France, Paris); Demoures, J. Y.; Lagorge, M.; de Nercy, B.; Stein, R. Radioprotection, 4: 89-108(1969). (In French).

The conflicts between the law of nuclear liability and insurance and the radioprotection law are discussed. The common law liability, principally in its application to radioprotection, is first considered from the viewpoint of penal liability, civil liability, and public power liability. Reparation of work accidents or professional exposure and civil liability is outlined. Civil liability in the nuclear energy area, an area with special regulations, is discussed with special reference to international agreements and the French law. The regulations of the Paris Convention and their implementation by French law are discussed. The provisions of nuclear insurance are outlined. (J.S.R.)

4640 MAXIMUM ADMISSIBLE CONCENTRATIONS IN AIR FOR 40 HOURS OF WEEKLY EXPOSURES OF RADIONUCLIDES PRODUCED BY THE THERMAL FISSION OF ^{235}U. Fourcade-Cancelle, N. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Radioprotection, 4: 143-53(1969). (In French).

The air-40-hours maximum permissible concentration applicable in radioprotection practice for a mixture of fission products formed by irradiation of uranium in a thermal flux was determined. The irradiation times considered were 30, 100, and 500 days and the cooling times from 1 day to 30 years. In the case of an irradiation of 500 hrs, for example, the maximum permissible concentration goes from 5×10^{-8} Ci/m^3 for one day of cooling to 3×10^{-9} for 30 years. (tr-auth)

Medicine

Protective Substances

Refer also to abstracts 4594 and 4697.

4641 (CEA-R-3809) EVOLUTION OF GLYCEMIA IN THE BLOOD OF MICE IN THE PRESENCE OR ABSENCE OF IMIDAZOLE. Polverelli, Michel; Teoule, Robert (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug. 1969. 22p. (In French). Dep. CFSTI (U. S. Sales Only).

The radioprotective effects of the heterocyclic compound, imidazole, on blood sugar levels of x-irradiated mice were studied. The results indicated that imidazole induced hypoglycemia and abolished the post-radiation hyperglycemia. There was an appreciable difference between the reactions of males and females. (auth)

4642 FATTY ACID CHANGES IN LIVER FRACTIONS OF PIGEONS AFTER LETHAL-DOSE RADIATION AND THERAPY. Chung, R. A.; So, E. S.; Shaw, D. H. (Tuskegee Inst., Tuskegee Institute, Ala.). Poultry Sci., 47: 1127-30(July 1968).

Fatty acid changes in the liver lipid fractions of pigeons were studied after lethal irradiation and delayed heterologous bone marrow, thymus, and spleen transplantation. The effective $LD_{100/30}$ for the pigeons (Columba livia) was 2500 rad. Heterologous bone marrow, spleen, and thymus from a single ring-neck dove (Streptopelia risoria) were used. Of 31 pigeons used, 29 received 2500 rad and 2 served as unirradiated controls (IC). The irradiated subgroups were designated. HMT, heterologous bone marrow transplant; HTT, heterologous thymus transplant; and HST, heterologous spleen transplant. The phospholipid fraction of the HMT group contained more essential fatty acids (linoleic and arachidonic acids) than any other transplanted group (HTT and HST). All 3 postirradiated transplanted groups (HMT, HTT, and HST) showed lower myristic and palmitoleic acid and higher stearic, linoleic, and arachidonic acid content compared to the irradiated control (IC) group. Oleic acid content of HMT was higher than that of the IC. Decrease in palmitic acid was accompanied by an increase in oleic acid. The triglyceride fraction of HMT, HTT, and HST groups contained more palmitoleic, stearic, oleic, and linoleic acid and less arachidonic acid than the IC group. Bone marrow (HMT), thymus (HTT), and spleen (HST) transplantation increased stearic and arachidonic acid content, HTT increased oleate, HST increased linoleate, HST and MMT increased palmitate, HTT decreased palmitate, and HMT and HTT decreased linoleate content. The HST treatment appeared to affect the content of palmitic, stearic, and oleic acids such that the value approached that of the normal unirradiated pigeons but tended to change linoleic and arachidonic acids in the opposite direction. It is suggested that arachidonic acid synthesis from linoleic acid may have decreased and/or that irradiation resulted in selective esterification of phospholipid and cholesterol ester with arachidonic acid. (BBB)

4643 RELATIONSHIP BETWEEN THE RADIOPROTECTIVE ACTION OF ANDROGENS AND THEIR ANABOLIC ACTION. Efimov, I. N. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 758-60(1968). (In Russian).

Male rats received a single injection of testosterone propionate or oxymetholone, 50 mg/kg of weight, 10 days before γ irradiation at a dose of 650 R. The administration of hormones increased the survival of the irradiated animals and lightened the course of radiation sickness, prevented a decrease in the incorporation of labeled amino acid into the total proteins of a number of organs (small intestines, spleen, etc.) in the long term periods of radiation sickness, and accelerated the process of restoration of weight. The anabolic effect of these hormones, expressed in a change in the rate of incorporation of labeled amino acid into protein and in a change in the weight of the animals, may be one of the radioprotective mechanisms. (JPRS)

4644 CHANGE OF METABOLISM DURING RADIOTHERAPY UNDER HYPERBARIC OXYGEN. Karcher, Karl H. (Univ., Heidelberg). Gann, 60: No. 1, 1-11(Feb. 1969). (In German).

Albino rats breathed hyperbaric oxygen at 3 atm, and changes of their serum lactic dehydrogenase (LDH), serum nicotinamide-adenine-dinucleotide (NAD), etc., were measured before and after the process. The effects of hyperbaric oxygen actions of adrenaline, adrenocortical steroids, and insulin and the radiosensitizing effects were also studied. The results obtained are as follows. Hyperbaric oxygen increased LDH, and promoted remarkably the LDH-increasing effect of adrenaline. In combined use with the hyperbaric oxygen, adrenaline increased serum lactic acid, but the lactic acid-increasing effects of insulin and adrenocortical steroids were reduced. Blood sugar value rose temporarily under the hyperbaric oxygen, but blood sugar-increasing effects of adrenaline and adrenocortical steroids were reduced by the hyperbaric oxygen. NAD was diminished by the hyperbaric oxygen. Acceleration of glycogen formation in liver after administration of adrenaline, insulin, and steroids was not influenced by the hyperbaric oxygen. Hyperbaric oxygen alone reduced slightly glycogen formation in liver. Normal and Walker carcinosarcoma-bearing rats were irradiated with a dose of 500 R under atmospheric pressure or hyperbaric oxygen. The results showed that in tumor-bearing rats irradiated under the hyperbaric oxygen, the increase of LDH was maximal and decrease of lactic acid was minimal, though the increase of LDH and the decrease of lactic acid were observed in both normal and tumor-bearing rats irradiated under the atmospheric pressure-oxygen. (TSS) (NSA of Japan)

4645 STUDIES ON THE MECHANISM OF ACTION OF SO-CALLED RADIATION-PROTECTIVE AGENTS AND DRUGS AGAINST RADIATION INJURIES. Barth, G.; Finger, H.; Bonnke, L. (Univ., Giessen, Ger.). Arzneim.-Forsch., 17: 763-7(June 1967). (In German).

Effects of whole-body x irradiation of mice at doses of from 450 to 600 R on production of agglutinin against Brucella abortus were studied. All of the radiation doses depressed production, which was not influenced by administration of 7-[2-hydroxy-3-(N-2-hydroxyethyl-N-methylamino)propyl]-1,3-dimethylxanthine pyridine-3-carboxylate (Complamin), aquocobalaminacetate (Aquocytobion), 1-(p-hydroxyphenyl)-2-(1'-methyl-3'-phenylpropylamino)-propanol-1 hydrochloride (Dilatol), or folic acid (Folsan). There was less depression of agglutinin production if the animals were pretreated by intraperitoneal injection of Freund's adjuvant seven or 14 days before irradiation. The complete oily phase of the adjuvant was more effective than the incomplete modification. (BBB)

4646 EFFECT OF PREDNISONE ON BONE MARROW CELLS REGENERATING FROM TOTAL-BODY IRRADIATION. Host, H. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 107-9(1968).

In studies on the effect of corticosteroids on regenerating marrow cells, corticosteroids were given to suppress the accumulation of lymphocyte-like cells during recovery from irradiation. How this influenced the final regeneration of the bone marrow cells is reported. Bone marrow of rats was examined 12 to 28 days after a whole-body x-ray dose of 310 R. Treatment with 0.5 mg of prednisone per day was started 7 days after irradiation. In prednisone-treated animals a pronounced lymphopenia remained during the experimental period, while the granulocytes rose to a level about 2 to 3 times the normal. In irradiated controls both lymphocytes and granulocytes increased gradually in numbers, and near-pretreatment counts were registered by the 28th day. The main effect of prednisone treatment on the regeneration of the bone marrow cells was the suppression of the lymphocyte-like cells to about 10% of the normal values. Furthermore, myeloid and erythroid cells in the prednisone-injected rats failed to recover, in contrast to the controls, in which a slow increase to normal numbers occurred. The accumulation of the lymphocyte-like cells on the 12th day in the controls subsided gradually, and the normalization of their number preceded recovery of myeloid and the erythroid cells. It was concluded that the lymphocyte-like cells play a role in the recovery of these cells, probably by acting as stem cells. (BBB)

Radiation Sickness and Injuries

4647 THE USE OF METHYLURACIL IN RADIATION EPITHELITIS AND DERMATITIS IN PATIENTS WITH PHARYNGEAL NEOPLASMS. Bogdanova, T. V. Vestn. Otorino-Laringol., 29: 80-2(May-June 1967). (In Russian).

Twenty-one patients suffering from cancer of the pharynx with radioinduced local changes in the tissues were observed. Fifteen of them developed epithelitis concurrent with dermatitis, whereas in 4 cases out of 6 there was a diverse marked inflammation of the skin of the neck. Epithelitis patients were subjected to insufflation of methyluracil into the pharynx, in dermatitis methyluracil ointment was used. Under the influence of methyluracil the inflammatory changes regressed and the possibility of analgesic action was not excluded. The use of methyluracil enabled continuation of radiation therapy in patients with marked dermatitis and epithelitis. (C.O.)

Radiodiagnosis

Refer also to abstracts 4325, 4429, 4515, 4543, 4577, and 4634.

4648 (LIB/Trans-231) A METHOD OF CLEARANCE INVESTIGATION WITH ^{51}Cr EDTA AT DECREASING PLASMA CONCENTRATION. Kuni, H.; Graul, E. H. Translated by U. Engelbert (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Atompraxis, 13: 357-60(1967). 15p. Dep. CFSTI (U. S. Sales Only).

Abstract of original article appeared as NSA 22: 460(1968). (Australia)

4649 (NP-18069) A BIBLIOGRAPHY OF ONCOLOGY (CROSS BIBLIOGRAPHY OF PAPERS COLLECTION). VOLUME IV. ISOTOPES, RADIOBIOLOGY, RADIOTHERAPY, CHEMOTHERAPY, SURGERY, BIOLOGICAL INVESTIGATIONS. Review Report No. 35. Skurzak, H.; Rybarska, M.; Gadek, A.; Wezyk, J.; Jasinski, W. (Instytut Onkologii, Warsaw (Poland)). 1969. 249p. (In several languages). Dep. CFSTI (U. S. Sales Only).

Fifteen-hundred references are presented to recent publications throughout the world on the etiology, diagnosis, and treatment of neoplasms. Treatment methods include the use of drugs, surgery, and radiations, alone or in combinations. (C.H.)

4650 (NYO-3175-55) NEW APPROACHES TO IMAGE FORMATION IN RADIOISOTOPE SCANNING. Progress Report, February 1, 1969-October 20, 1969. Kuhl, David E. (Pennsylvania Univ., Philadelphia Dept. of Radiology). Contract AT(30-1)-3175. 7p. Dep. CFSTI.

The development of new systems for extracting more information from emission imaging of patients is discussed. An on-site digital processing system that provides a wide and flexible range of secondary data operations, direct picture display on a CRT screen, and full-operator control of processing and display operations at the time of the viewing is particularly discussed. The Mark III brain scanner is also included. A list of publications and presentations that evolved from this research is included. (C.O.)

4651 (TID-25256) RADIATION DOSIMETRY AND BIOLOGICAL TURNOVER OF RADIONUCLIDES USED IN NUCLEAR MEDICINE IN PRENATAL AND POSTNATAL SUBJECTS USING STABLE AND RADIOACTIVE TRACERS. Progress Report. Brill, A. B. (Vanderbilt Univ., Nashville, Tenn.). Oct. 31, 1969. Contract AT(40-1)-2401. 38p. Dep. CFSTI.

A whole-body counter was calibrated for the collection of γ energy spectra over a wide energy range from different segments of the scan length using unshielded and collimated detectors. A high energy honeycomb collimator was tested. The transport of ^{59}Fe and ^{131}I from the mother to the fetus was measured in pregnant women, and calculations were made of the radiation dose to the total fetus and fetal organs. The radiation dose from tracer amounts of ^{75}Se-methionine was calculated from whole-body counting data using computer analysis. Good results were obtained when comparison was made with urine excretion measurements and analysis of biopsy and autopsy samples. The distribution of ^{131}I-human serum albumin in normal individuals and those with abnormal cerebrospinal fluid flow patterns were studied following injection into the subarachnoid or extra arachnoid space. The retention of intravenously injected ^{133}Xe in saline in the tissues was investigated in spider monkeys using a scintillation camera for counting. Results showed that retention in tissues could increase the radiation dose by a factor of 10. The whole-body retention, plasma clearance, and erythrocyte uptake of ^{55}Fe and ^{59}Fe were followed for up to 465 days following the administration of tracer doses to normal individuals. A procedure was developed for determining the content of Fe in whole blood, plasma, and erythrocytes using stable ^{58}Fe as the tracer followed by activation of samples and counting the activity of ^{59}Fe induced by the reaction ^{58}Fe(n,γ)^{59}Fe using a high-resolution Ge(Li) semiconductor detector. The method was used to follow Fe uptake and distribution following oral administration to pregnant women. Erythrocyte volumes and intraventricular hemorrhage were measured in infants with hyaline membrane disease using injected ^{50}Cr-labeled erythrocytes as tracers for dilution studies. The uptake and distribution of vitamin B_{12} and Fe were studied in Rhesus monkeys and human patients using ^{58}Co-labeled vitamin B_{12} and ^{59}Fe. The transport of Fe across placental membranes was studied in sheep following administration of ^{55}Fe or ^{59}Fe to the mother or fetus. Body composition studies were conducted in patients treated for massive exogenous obesity with surgical bypass of large segments of the ileum. Sodium-24 was used as a tracer to measure exchangeable Na spaces in relation to hypertension during the menstrual cycle. (C.H.)

4652 DISTRIBUTION OF THE BONE MARROW IN THE NEWBORN. Cuau, F.; Gaston-Carrere, J. P.; Lefebvre, J.; Parmentier, N. C. (CEN, Fontenay-aux-Roses, France). Rev. Fr. Etud. Clin. Biol., 13: 584-90(June-July 1968). (In French).

The proteins were removed by ethylene-diamine following Williams and Irving's technique as modified by Losee. Then, a plastic material, Stratyl A 116 (Saint-Gobain) chosen for its physical characteristics, being near to those of bone marrow, was injected to take the place of the proteins. After each operation, the bones were weighed so that the difference, in their weights gave the ratios between bone and marrow, and the total marrow weight. With this technique, all the bones of the skeleton of a new-born were studied. The results are expressed in weights and percentages referring to the total weight of marrow. Comparisons were made with other results for children and adults. The results of Toppic expressed in percentages of the whole medullar volume are in good agreement with our results, though the techniques are very different. In both cases, the percentage of marrow in cranial bones was important, with values equal to the sum of ribs, spinal column, pelvis and scapular region. The comparison with adult studies by Mechanik (with corrections of Ellis) shows: a large decrease of the marrow in adult skulls; an increase (factor 2) of the percentage in vertebrae, especially in lumbar vertebrae where the factor reaches 5; an increase of the percentage in the sacrum of adults; an inversion of the percentages between the scapular belt and pelvis in the adults; no change for the ribs. (auth)

4653 RADIOISOTOPIC EVALUATION IN ONCOLOGY. Girolamo, Rita F.; Sall, Sanford (New York Medical College. Metropolitan Hospital Center, New York). Clin. Obstet. Gynecol., 12: 398-422(June 1969).

Newer radiopharmaceuticals and radioisotope-labeled compounds have become an integral part of our armamentarium in the diagnosis of cancer. Unfortunately efforts to accomplish selective localization of specific radionuclides and other labeled compounds by malignant tissue has been generally unrewarding. Continued research in the metabolism of tumor cells and tissue ultimately will demonstrate specific tumor constituents that subsequently can be labeled, and thus compounds can be developed for selective tumor concentration. This projected advance in the development of radiopharmaceuticals and scintillation scanning not only will improve our ability to diagnose cancer, but will afford use of these agents for their pharmacologic response in cancer therapy. (auth)

4654 STUDIES ON RADIOLOGICAL DIAGNOSTICS IN THYROID NODULES. Morisaki, Rokuro (Tottori Univ., Japan). Yonago Igaku Zasshi, 20: 76-85(Feb. 1969). (In Japanese).

Techniques of radioisotope and x-ray examinations of thyroid nodules were experimentally and clinically examined, and the following results were obtained. From the experiment with a phantom, it was shown that ^{125}I and ^{99m}Tc are superior to ^{131}I in representing contour and size of thyroid in a scintigram, and of these three, ^{99m}Tc is the best in revealing superficial and deeply seated nodules as cold nodules. In clinical cases, the size of extirpated nodule specimens was compared with that of defects on the scintigram. The results showed that the defect images were smaller than the actual size in all cases, and the defect images obtained by ^{125}I and ^{99m}Tc approximated more closely the measured size than that by ^{131}I. ^{99m}Tc was best for resolving power. According to ^{131}I-scanning of 113 patients with thyroid nodules, the percentage with which thyroid nodules were revealed as cold nodules on scintigram was about 80%. There was no difference in revelation rates of malignant adenoma and benign nodular goiter as cold nodules. As for the form of cold nodules, many unilateral total defects or eroding defects were observed in malignant cases, and many compressing defects were seen in benign cases. From x-ray findings of the cervical region of 226 cases with struma, a high incidence of calcification in the nodular type was shown. Many spherical and ring-shaped calcifications were observed in benign cases, and many nebulous and irregularly fused calcifications were seen in malignant cases. Pneumothyroid performed in 10 cases showed that the representation of nodular contour was possible in 6 cases, and all these 6 cases were benign nodular goiter. (TSS) (NSA of Japan)

4655 THE IMPORTANCE OF SPLEEN SCINTIGRAPHY IN MALIGNANT LYMPHOMAS. Fuezy, M.; Karika, S.; Tarjan, G. (State Inst. of Oncology, Budapest). Neoplasma; 16: 447-50(1969).

Scintigrams were performed on red cells from 102 malignant lymphoma patients; the red cells were labeled with ^{51}Cr and damaged by heat. The scintigrams were used for detection of cryptic splenomegalia and tumorous infiltration of the spleen. In some cases changes of the spleen shown by the scintigrams reflected the progression or regression of the disease. (auth)

4656 SECOND NATIONAL CONGRESS OF NUCLEAR MEDICINE, TEL AVIV, ISRAEL, DECEMBER 20–21, 1965. Program and Abstracts of Papers. Tel-Aviv, Israel, Tel-Aviv University, [1966]. 80p. (CONF-651223–(Absts.)).

Abstracts of approximately 70 papers presented at this conference are included. Emphasis was placed on radioisotope scanning procedures and recent advances in radiotherapy. For abstracts of individual refer to CONF-651223 in the report number index. (C.H.)

Radiotherapy

Refer also to abstracts 4629, 4656, 4692, 4694, and 4696.

4657 ISOCHRONOUS CYCLOTRON INSTALLATION FOR RADIONUCLIDE PRODUCTION. Laughlin, John S.; Mamacos, James P.; Tilbury, Roy S. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)910. Radiology, 93: 331-7(Aug. 1969).

The installation and operation of an isochronous cyclotron and associated laboratories for the medical use of radionuclides have been described. The cyclotron is of the isochronous type and is the first helium-3 accelerator to be installed in a medical research institution. The various component laboratories of the installation have been designed to provide maximum utilization and minimum radiation interference, within given space limitations. The uniquely important radionuclides for biomedical research—carbon 11, oxygen 15, nitrogen 13, as well as fluorine 18, iron 52, iodine 121, iodine 123, chromium 48, and many others—are produced with this positive-ion accelerator. The short half-life of many of these nuclides makes it possible to use them in much larger doses. Many of them are positron emitters which make possible three-dimensional localization. Experience demonstrates the importance and the utility of a small cyclotron, particularly with the capability of helium-3 ion acceleration, in a medical institution for research and diagnosis. (auth)

4658 CYTOMORPHOLOGICAL CHANGES IN CANCER OF THE MAMMARY GLAND UNDER THE INFLUENCE OF RADIATION THERAPY. Agamova, K. A. (Inst. of Oncology, Moscow). Vop. Onkol.; 15: No. 9, 34-41(1969). (In Russian).

The morphology of cells and peculiarities of cytograms prior to (punctures) and after (curretage specimens from the removed tumor incisions) preoperative roentgenography in 120 patients with cancer of the mammary gland were investigated. Radiation changes in cancerous tumor cells were observed in 109 patients. It was demonstrated that radiosensitivity of cells in cancerous tumor parenchyma could be determined in some patients prior to treatment by morphological properties of cell elements in punctures. (auth)

4659 METHOTREXATE AS AN ADJUVANT TO RADIOTHERAPY OF SQUAMOUS CELL EPITHELIAL CARCINOMA IN THE NECK–NOSE–EAR REGION. Ryssel, H. J.; Sonntag, R. W.; Brunner, K. W. (Inselspital, Bern). Schweiz. Med. Wochensch., 99: 1051-7(July 19, 1969). (In German).

Evidence was sought for a synergistic action of the folic acid antagonist methotrexate in the radiation treatment of squamous cell carcinomas of the otorhinolaryngologic area. Most of the 63 patients had either extensive local tumor invasion, regional lymph node involvement, or distal metastases. Various dose schedules were given either as preirradiation treatment, simultaneous treatment, or late postirradiation therapy at the time of recurrence. In the pre-irradiation therapy group, 12 to 20 patients showed an average of 30 to 50% tumor regression. In this group the methotrexate dose schedule of 2.5 mg 3 times daily for 3 days, repeated at weekly intervals for 3 to 4 weeks, proved to be effective, relatively safe, and well tolerated. One third of these patients remained tumor free for over 6 months, and 3 cases for over 2 yr. The results of simultaneous therapy with methotrexate and irradiation were unsatisfactory. All 14 cases in this group showed increased mucous membrane toxicity which forced either early interruption or complete cessation of radiotherapy in many cases. Late therapy with methotrexate following intensive radiotherapy produced with methotrexate following intensive radiotherapy produced tumor regression in 19 of 29 patients. The regressions were generally brief, ranging from a few weeks to several months. The therapy, therefore, afforded only transient palliation and probably had no influence on survival. Five of 8 cases in this group treated with high-dose methotrexate intravenous infusions at 8- to 14-day intervals showed satisfactory results. These cases had local tumor recurrence in previously heavily irradiated areas with decreased vascularization. For patients with distal metastases or recurrences in an area not previously having had extensive radiotherapy the 3-day oral methotrexate therapy as used in preirradiation therapy also provided effective palliation. (BBB)

4660 LYMPHOCYTE POPULATIONS IN CHRONIC LYMPHOID LEUKAEMIA AND THEIR RESPONSE TO SPLENIC IRRADIATION. Peckham, M. J.; Parmentier, C. (Institut Gustave-Roussy, Villejuif, France). Rev. Fr. Etud. Clin. Biol., 13: 591-7(June-July 1968). (In French).

The transformation of lymphocytes cultured with phytohaemagglutinin (PHA) in vitro has been assessed using an autoradiographic method in eight patients with chronic lymphatic leukemia before and at various times after therapeutic splenic irradiation. In all, except one case, irradiation of the spleen resulted in a marked fall in the PHA-insensitive lymphocyte population. In three cases, all of whom showed evidence of impaired marrow function, there was a concomitant depression of the PHA-sensitive population. In one patient it was possible to characterize the PHA-insensitive lymphocyte population morphologically, and microspectrophotometric determinations of nuclear DNA content showed that the abnormal lymphocytes constituted a tetraploid mutant population coexisting in the peripheral blood with a morphologically normal diploid small lymphocyte population. Cytogenetic analysis confirmed that only the diploid lymphocytes proceeded to mitosis when incubated in vitro in the presence of PHA. Splenic irradiation in this case exerted a greater effect on the PHA-sensitive lymphocytes. The significance of the findings in relation to the known immunological defects which occur in chronic lymphatic leukemia is briefly discussed. (auth)

4661 RESULTS OF THE TREATMENT OF OAT-CELL BRONCHIAL CARCINOMA BY RESECTION, FAST ELECTRONS (35-MeV BETATRON) OR CYTOSTATIC DRUGS, AND THERAPEUTIC CONSEQUENCES. Loerbroks, Barabara (Staedtische Klinik, Berlin-Wannsee). Beitr. Klin. Erforsch. Tuberk., 135: 388-407(1967). (In German).

Results of treatment of microcellular or oat-cell bronchial carcinomas with up to 6000 or 7000 R of 35-MeV electrons by betatron alone or in combination with cytostatic drugs or surgical resection are reported. Follow-up of 83 patients was made over a period of 22 months. Of the total, 30 were only symptomatically treated, 33 received megavolt therapy with 35-MeV electrons, nine received combined treatment with 35-MeV electrons and cyclophosphamide or podophylline, and one was treated with 35-MeV electrons following transthoracic implantation of ^{198}Au seeds. After 22 months one patient was alive after pneumonectomy and postoperative 35-MeV electron therapy. Out of 14 treated with fast electrons five were alive. No patient from the group treated with fast electrons and cytostatic drugs was alive. (BBB)

4662 RADIATION THERAPY IN RETINOBLASTOMA. AN ANALYSIS OF 230 CASES. Cassady, J. R.; Sagerman, R. H.; Tretter, P.; Ellsworth, R. M. (Columbia Univ. Coll. of Physicians and Surgeons, New York. Radiology, 93: 405-9(Aug. 1969).

Two hundred thirty cases of retinoblastoma have been analyzed. The stage (group) of disease when the patient is first seen affords an accurate prognosis. Local tumor control rates are 84, 67, 69, 30, and 15 per cent in Groups I to V, respectively. Intra-arterial and intramuscular triethylene melamine has not improved the outcome with irradiation and is now employed primarily in Groups IV and V patients. (auth)

4663 INTERSTITIAL CURIETHERAPY, WITH AFTERLOADING, IN RADIOSURGICAL TREATMENT OF LYMPHATIC METASTASES OF THE NECK. Sahatchiev, A.; Mouchmov, M. (Scientific Oncology Inst., Sofia). J. Belge Radiol., 52: 143-6(1969). (In French).

A new technique for interstitial radium therapy with afterloading and fractionation of the dose, combined with complete ganglionic removal from the neck is described. Irradiation is only started after cicatrization of the surgical wound and the total dose of 7,200 to 8,200 Rads is given at the rate of a daily 350 to 500 Rads. In this way it is possible to deliver, without any danger of necrosis, a total dose twice that usually possible. (C.O.)

4664 RADIOTHERAPY OF TUMORS OF THE MANDIBLE. Pasquinelli, V.; Pastremoli, A. (Univ., Bologna). Radiobiol. Radioter. Fis. Med.; 24: 15-37(Jan-Feb 1969). (In Italian).

Results of radiotherapy of 36 cases of tumors of the mandible treated in the Radio Institute in Bologna from 1950 to 1967 are reported. Prevailingly high energies were used (especially with ^{137}Cs) with distinct advantages from a technical as well as from a clinical point of view. The percentage of survival five years after radiotherapy was found to be 23.5%. In surgical cases the survival was not notably better and it is believed that radiotherapy alone may be considered as an alternative to surgery. (auth)

4665 TREATMENT OF KELOIDS WITH BETATRON ACCELERATED ELECTRONS. Colosimo, M.; Spina, C. (Univ., Rome). Nunt. Radiol., 34: 607-22(July 1968). (In Italian).

After a summary of etiopathogenesis and histology of keloids, the various therapeutic possibilities are considered. The different types of radiation therapy are described in detail, with particular regard to accelerated electrons. A list of patients treated at the Rome University Institute of Radiology with betatrons is presented in tabular form. It is stated that betatron has to be preferred to plesioroentgentherapy, not only for the different cure percentage, but also and chiefly because it minimizes the amount of radiation scattered on areas not directly affected by the lesion. This meets protection requirements, which must always be considered in radiation therapy of benign neoplastic diseases. (auth)

4666 RADIOSENSITIVITY TESTING: A MODERN ADJUVANT IN THE TREATMENT OF CERVICAL CANCER. Cohen, Carmel J.; Gusberg, S. B. (City Univ. of New York. Mt. Sinai Hospital, New York). Clin. Obstet. Gynecol., 12: 335-53(June 1969).

Three broad approaches to the problem of radiosensitivity have been presented: histologic measurement of response; cytologic measurement and prediction of response; and cytochemical and cytomorphologic measurement of response. This latter approach culminated in the development of our radiosensitivity testing (RST) program. Other avenues have been explored such as testing the response of buccal mucosa as an index of radiosensitivity, or the measurement of nucleoprotein change during radiation through the uptake of labeled materials. Autoradiography, quantitative cytologic techniques, and electronmicroscopy have also been used in an effort to clarify further the problems of cell differentiation and cell death under radiation. All of these efforts add refinement to our knowledge about the behavior of the cell but unfortunately they have not solved the problem of virulence nor have they provided new meaningful clinical application. The basic problem of selecting a method of treating the patient with cancer of the cervix when two excellent modalities (radiotherapy and extended surgery) are available still exists. We have found that after sorting all of the variables, the patient's RST response is the most reliable parameter on which to base the therapeutic decision. The testing technique is simple, the interpretation can be learned easily and is reproducible, and there is no patient morbidity incurred. We have adapted our protocol to the patient's response, and in this way we can best employ surgery and radiotherapy, two excellent therapeutic modes, in the individual treatment of patients with cervical cancer. (auth)

4667 INTRACAVITARY TREATMENT OF TUMORS OF THE BLADDER WITH CYTOTOXIC AGENT (MITOMYCIN C) AND RADIOACTIVE PHOSPHORUS (^{32}P). 1. Ogawa, Hideya (Nippon Medical School, Tokyo). Nippon Hinyokika Gakkai Zasshi, 60: 717-23(Aug. 1969). (In Japanese).

Intracavitary radiation and chemotherapy with cytotoxic agents are usually indicated for tumors of the bladder with, reportedly, some success in attaining complete disappearance, or contraction of the tumor and prevention of neoplastic regeneration. However, laboratory studies published concerning these techniques of therapy as yet are few. The present investigation was undertaken to determine blood and vesical tissue levels of the antitumorgenic agent mitomycin C (referred hereinafter to as MMC) and of radioisotope ^{32}P following intravesical instillation as well as to follow histological changes of the bladder and tumor. A clinical study was also performed in a series of 25 patients to determine whether the intracavitary treatment might be beneficial in ameliorating the grade and stage of the vesical tumor. (1) Plasma levels of MMC were found to in no instances exceed 0.002 mcg/ml either after a single dose or over 20 days of administration of every 48 hours at dosage level of 2 ml of a 1,000 mcg/ml solution in mature rabbits. (2) After the instillation of ^{32}P solution of a 0.1 mCi, the highest plasma levels of 20 cpm approx. were observed at 1 and 3 hours respectively with a subsequent diminition to the lowest level at 12 hours. Reelevation of the radioactive phosphorus in the plasma to $\frac{1}{2}$ and $\frac{1}{3}$ of the peak level was evident at 24 and 48 hours post administration respectively. There existed a tendency for the intracavitary instillated ^{32}P to accumulate in the blood over 20 days of administration at every 48 hours. The plasma levels of ^{32}P after 10 doses of the solution given at 48-hour intervals were approximately six times as high as the peak levels after a single dose. (3) Management of MMC in combination with ^{32}P produced plasma levels of the chemotherapeutic agent again lower than 0.002 mcg/ml, whereas radioactivity in the blood was slightly greater in these instances than after administration of the radioisotope alone and, moreover, the rate of elevation of radioactivity in the blood increased with the increase in number of doses. The finding appears to indicate possible enhancement of ^{32}P absorption due to alterations in vesical mucosa arising from the concomitant use of MMC. (NSA of Japan)

4668 POSTOPERATIVE RADIATION THERAPY OF CANCER OF THE BREAST. Watanabe, Katsushi (Kyushu Univ., Fukuoka). Fukuoka Igaku Zasshi, 60: 241-6(Apr. 1969). (In Japanese).

The significance of postoperative irradiation of breast cancer is to prevent recurrence or metastasis. The data from the author's department and the recent literature are reviewed in order to evaluate the effectiveness of postoperative radiotherapy. In the author's department, patients were given conventional postoperative irradiation with a 5 year survival rate of 55.5 per cent. An apparent dose-dependency was noted: patients receiving dose level above 3000 R had a 5 year survival rate of 83% in contrast to 70% with dose level under 3000 R. The use of tangential irradiation with ^{60}Co resulted in an improved prognosis with a 3 year survival rate of 77.7 per cent. A significant decrease in pulmonary disturbances was also noted: incidence of radiation pneumonia was 49% with ^{60}Co irradiation in contrast to 64% with conventional radiotherapy. Recurrence of cancer within the irradiated fields was also decreased to 23.5% compared to 64.5% with conventional irradiation. However, incidence of remote metastasis was found to be considerably higher; 70.6% with ^{60}Co in contrast to 27.4% with conventional radiotherapy, indicating the limitation of ^{60}Co irradiation. (NSA of Japan)

4669 RANDOM DOSAGE OF ^{131}I IN THE TREATMENT OF HYPERTHYROIDISM: RESULTS OF A PROSPECTIVE STUDY. Skillman, T. G. (Ohio State Univ., Columbus); Mazzaferri, E. L.; Gwinup, G. Amer. J. Med. Sci., 257: 382-7(June 1969).

The relation of radioiodine dose in hyperthyroidism therapy to the incidence of hypothyroidism, a serious complication of radiotherapy, was examined. A prospective study was made of 70 patients with diffuse goiter and hyperthyroidism, treated randomly with either 6, 9, or 12 mCi ^{131}I and followed a minimum of 2½ yr. The mean dose of ^{131}I/g of thyroid tissue for each group was 132, 198, and 271 μCi ^{131}I respectively. A statistically identical degree of hypothyroidism in the range of 50 to 60% occurred in each group. However, highly variable individual responses within each group were observed with doses as small as 50 μCi/g producing hypothyroidism and doses as large as 300 μCi/g being ineffective and necessitating retreatment. There seems to be a narrow margin of efficacy for ^{131}I between 80 and 130 μCi/g. There is a low incidence of myxedema with an undesirably slow response at one end of the narrow spectrum and a prompt therapeutically effective response with a high occurrence of myxedema at the other end. The high degree of individual variability to radioiodine observed here indicates that further modifications in dose below 80 μCi/g will not completely resolve the problem of posttherapeutic myxedema.(BBB)

4670 PERORAL IRRADIATION OF CARCINOMA OF THE ORAL TONGUE. Fayos, Juan V.; Lampe, Isadore (Univ. of Michigan Medical Center, Ann Arbor). Radiology, 93: 387-94 (Aug. 1969).

Peroral x irradiation has been used as the sole method of treatment of carcinoma of the oral part of the tongue in 80 patients at the University of Michigan during the years 1940 through 1960. The application of a peroral technique to a considerable variety of lingual lesions was made possible by the use of malleable thin-walled lead cones. This practice has advocated this technique in preference to radium needle implants or external irradiation in selected carcinomas arising on the lateral border and the ventral aspect of the tongue which have not extended to the floor of the mouth, the anterior tonsillar pillar, or into the tongue for more than 1.5 cm. Of the 80 patients so treated, 41 were alive at five years, absolute rate of 51.3 per cent (58.6 per cent determinate). Five additional patients were salvaged by surgical procedures after postirradiation recurrence, raising the absolute 5-year survival to 57.5 per cent (65.7 per cent determinate). In the most recent material (1955 through 1960) the 5-year survival rate is 65 per cent absolute (81.3 per cent determinate) with two cases salvaged by surgery after recurrence raising the survival to 75 per cent absolute (93.8 per cent determinate). The rate of control of the primary lesion increased from 50 per cent in the 1940 through 1944 period to 76.2 per cent from 1945 through 1954 to 90 per cent in the 1955 through 1960 period. Radionecrosis of the mucosa of the tongue in portions of the irradiated area, the only complication encountered, occurred in half of the patients. The area of necrosis was superficial and healed spontaneously. (auth)

Radiation Effects on Animals

Refer also to abstracts 4605, 4658, and 4666.

4671 (NYO-3970-16) REPAIR OF RADIATION DAMAGE IN MAMMALIAN CELL POPULATIONS. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Oct. 1968. Contract AT(30-1)-3970. 18p. (CONF-681052-1). Dep. CFSTI.

From Conference on Radiobiology, New York.

A review of the literature on cellular and tissue response to irradiation is presented. Experiments on effects of x radiation on reproductive capacity of HeLa cells are reviewed with emphasis placed on cell survival curves and cell population kinetics. Cell populations in the adult are classified as increasing, decreasing, steady-state renewal, and static; effects of radiation on these are discussed. Studies on fractionation survival curves and effects of age on survival of irradiated hamster cells are reviewed. It is suggested that survival kinetics during the recovery period represent the combined effects of two simultaneous processes: intracellular repair of sublethal damage which results in a prompt, initial rise in two-dose survival, and the concomitant progression of cells toward division which results in fluctuations or oscillations in two-dose survival. Reviews are also given of studies on single cell in vivo assay of cell survival using mouse leukemia cells; two-dose fractionation curve for oxygenated Ehrlich ascites cells x-irradiated in vitro and assayed in vivo; survival curves for the colony-forming ability of mouse bone marrow cells irradiated in cell suspension in vitro and in vivo; and recovery and repopulation in intestinal epithelium of x-irradiated mice. (H.L.W.)

4672 (NYO-3970-17) STUDIES ON LYMPHOID CELL PROLIFERATION UNDER CONTINUOUS IRRADIATION. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Oct. 1968. Contract AT(30-1)-3970. 19p. (CONF-681055-1). Dep. CFSTI.

From Medical Research Seminar, Upton, N. Y.

The kinetics of lymphoid cell proliferation was examined using γ radiation as a tool in the study of cellular control mechanisms and lymphoid cell population kinetics of the thymus and spleen of mice. Mice were irradiated at 45 Rads/day for periods up to 16 weeks to study the accumulated of damage affecting cell proliferation and the speed and efficiency of regeneration. Parameters investigated included the weight of the thymus (and spleen for comparison), histological changes in the thymus cortex, cell type distribution, and percentage labeling index. Increased proliferative activity of the precursor cells was found, presumably to maintain a steady level of cell population. Data on pulse-labeling, repeated labeling, percentage labeled mitoses, and grain count decrements showed an increased proliferation rate in all lymphocyte cell compartments, little or no change in the median cell cycle time, but a decrease in the spread of cell cycle times. It was concluded that the thymus tissues could achieve a near-steady state of cell population under these experimental conditions. The mechanisms involved are discussed. (C.O.)

4673 AGE RESPONSE TO X-RADIATION OF MURINE LYMPHOMA CELLS SYNCHRONIZED IN VIVO. Mauro, F.; Madoc-Jones, H. (Washington Univ., St. Louis). Proc. Nat. Acad. Sci. U. S., 63: 686-91(July 1969).

Cells of a transplantable murine lymphoma line were partially synchronized in vivo by administration of a single dose of 0.5 mg of hydroxyurea per lymphoma-bearing mouse. At various times after administration of hydroxy-urea, the femurs of the lymphomatous mice were x-irradiated, and the number of lymphoma colony-forming units per femur were then assayed by the spleen-colony technique. A well-defined age response to irradiation of the lymphoma cells in vivo, similar to that of HeLa cells in vitro, was observed. (auth)

4674 SYSTEMATIC MICROSCOPIC STUDY OF THE ACTIONS OF RADIATIONS ON ANIMAL CELLS IN CULTURE. IV. INVESTIGATION BY ELECTRON MICROSCOPE OF EMBRYONIC FIBROBLASTS OF MICE SUBMITTED TO γ IRRADIATION. Puvion, F.; Cappelaere, P.; Demaille, A.; Driessens, J. (Institut de Recherches sur le Cancer, Lille). Compt. Rend. Soc. Biol., 163: 662-4(1969). (In French).

Embryonic fibroblasts were given 150, 400, 700, and 2,200 rads of γ radiation and examined 90 min, 48 hr, 4 and 8 days later. The normal control fibroblasts were examined after 48 hr, 5, 9, and 14 days of culturing. Electron microscope examinations of the fibroblasts showed the absence of nuclear or nucleolar lesions, the presence of frequent and intense vacuolization in the cytoplasm, quantitative variations in glycogen that diminished between 4 and 8 days after irradiation, appearance of an abundance of lipid products, and a total cytolysis after a 2,200 rad dose. (H.L.W.)

Invertebrates

Refer also to abstracts 4578, 4604, and 4707.

4675 (STI/PUB-21/36(Vol.4)) RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY. VOL. IV. (1966-1967). Bibliographical Series No. 36. (International Atomic Energy Agency, Vienna (Austria)). 1969. 822p. IAEA $22.00. Dep.

This fourth volume in a series of bibliographies contains 1800 references. The work is annotated and abstracts are included where possible. Aids to the user provided include broad classification scheme for different areas of work, author index (includes affiliation), subject index, taxonomic index, and tables of insecticides. (C.O.)

4676 DAMAGE TO TESTES AND RECOVERY OF FERTILITY IN BOLL WEEVILS FED CHEMOSTERILANTS. Reinecke, Lonna H.; Klassen, Waldemar; Norland, Jerome F. (Agricultural Research Service, Fargo, N. Dak.). Ann. Entomol. Soc. Amer., 62: 511-25(May 1969).

Studies of mating and histology were made to test the fertility and spermatogenic activity of male Anthonomus grandis Boheman (Coleoptera: Curculionidae) several weeks after the weevils were fed the following chemosterilants: apholate; busulfan (1,4-butanediol dimethanesulfonate); 1-aziridinylphosphonic acid cyclic diester with pentaerythritol; D-mannitol 1,6-dimethanesulfonate; N,N,N′,N′-tetramethyl-P-piperidinophosphonic diamide; and N,N,N′,N′-tetramethyl-P-morpholinophosphonic diamide with and without 2 kRad of x rays. Damage to the spermatogenic cycle and the histopathology of testes from treated weevils are described. All chemical treatments at one of the concentrations used caused permanent damage to the testes of some weevils as evidenced by the death of all spermatogonia. However, none of the treatments caused permanent damage to all the testes at the concentrations used. Damage to the midgut occurred with some chemosterilants. Remating studies showed that recovery of fertility could occur after 4 weeks with three chemosterilants, although the data for D-mannitol 1,6-dimethanesulfonate were insufficient for a firm conclusion. (auth)

4677 EFFECT OF GAMMA RADIATION ON TISSUES OF THE TOBACCO BUDWORM, HELIOTHIS VIRESCENS. Vinson, S. Bradleigh; Londono, Ruby L.; Bartlett, A. C. (Mississippi State Univ., State College). Ann. Entomol. Soc. Amer.; 62: 1340-7(Nov 1969).

Fifth stage larvae and 6-day-old pupae of H. virescens (F.) were irradiated with a cobalt-60 source. Damage to various organs was studied. Testes and wing pads appeared to be the most sensitive tissue in both larvae and pupae. Radiation caused some of the epidermal cells of the developing wing pads to enlarge causing an irregular adult cuticle to be produced. Radiation also caused the production of bridges of cuticle between the upper and lower lamellae of the wing pads which prevented the expansion of the adult wing. Death in the pupal stage was often due to failure of the adult to free its wings from the pupal case. Larvae stopped feeding following irradiation, the midgut epithelial cells enlarged and later disintegrated. Midgut cell replacement was curtailed. The peritrophic membrane was reduced or absent possibly because of damage to the secretory cells. Fat body cells appeared to be depleted of their stored nutrients. The cuticle failed to separate from the epidermal cells. This failure may have been due to radiation affecting the production of hormones in the endocrine system or enzymes involved in digestion of the old cuticle. Death of larvae following irradiation appeared to be due to failure to molt at higher doses and to energy depletion which may also account for the reduced adult life span. Irradiation effects on testes were noted, and chromosomal bridging was observed in the germ cells. (auth)

4678 FACTORS DETERMINING RATES OF THE EVOLUTION OF FITNESS IN LABORATORY POPULATIONS OF DROSOPHILA PSEUDOOBSCURA. Strickberger, Monroe W. (St. Louis Univ.). Genetics, 62: 639-51(July 1969).

Laboratory populations of Drosophila pseudoobscura isogenic for different Arrowhead (AR) third chromosome arrangements were maintained for a 20-month evolutionary period in cages, and then tested for their relative fitnesses in population cage competition with a uniform set of strains carrying the Chiricahua third chromosome arrangement. Those isogenic AR chromosomes which had been exposed at 60-day intervals to different degrees of x-ray irradiation (500 R to 3,000 R) showed generally no increase in their relative fitness compared to isogenic AR strains which had not been irradiated. However, significant improvements in relative fitness were observed for AR strains derived from population cages in which more than one isogenic AR strain was present; the relative fitnesses of AR chromosomes (according to the number of different AR strains involved) were in the order $1 < 2 < 4 < 6 = 8$. These results suggest that newly induced variation provided by x rays is relatively ineffective in the evolution of fitness in a population compared to the natural variation already existing in the population. (auth)

Vertebrates

Refer also to abstracts 4561, 4565, 4567, 4569–4572, 4579, 4580, 4583, 4599, 4605, 4609, 4641–4646, and 4700.

4679 (AD–690879) EFFECTS OF PULSED GAMMA-NEUTRON RADIATION UPON THE PERFORMANCE OF THE UNFETTERED MONKEY. Kaplan, S. J.; Gresko, E. M. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1969. 24p. (AFRRI-SR–69-9). CFSTI.

Information indicating that unrestrained subhuman primates are capable of performing a learned task following a 4000-Rad (midline tissue dose) pulse of irradiation is presented. The animals exhibited a measurable performance decrement postirradiation; the most severe decrements occurred within the first 2 hours postpulse. Except during the period of early transient incapacitation, however, the animals were able to perform at a near normal level until shortly before death, at which time they became totally incapacitated. (USGRDR)

4680 THORACIC DUCT LYMPHOCYTE OUTPUT IN RATS AFTER LOCAL THYMUS IRRADIATION. Engeset, A.; Schooley, J. C. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 119-23 (1968).

The effect of local, 400-R irradiation of the rat thymus on the lymphocyte output of the thoracic duct was studied. This procedure should eliminate the lymphocytes from the thymus without affecting function of epithelial elements, and answer the question whether or not thymus lymphocytes contribute to the recirculating pool. Cannulation of the thoracic duct was performed on day 5 after irradiation and the hourly output of lymphocytes was measured. In the thymus-irradiated group the hourly output dropped to about 50% of that in the control group. This was probably caused by the destruction of the thymocytes and not by an alteration of the humoral function of the thymus. The reduction in the lymphocyte output after irradiation was as great as that found after surgical thymectomy. Evidently the rat thymus normally contributes large numbers of lymphocytes to the recirculating pool. (BBB)

4681 CONTRIBUTION TO AN INVESTIGATION ON THE EFFECT OF X RAYS ON THE CLINICAL PICTURE, PERIPHERAL BLOOD, AND HEMATOPOIETIC APPARATUS OF PIGLETS AGED 2 TO 3 MONTHS. Gacevic, M. (Inst. for Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Acta Vet. (Belgrade); 18: 223-32(1969). (In Slovak).

The acute radiation syndrome was studied in two to three month-old pigs exposed to 500 R of x rays. Leukopenia was most marked on the seventh day after irradiation when the number of leukocytes had fallen to 6,675 per cu.mm of peripheral blood as compared to 23,000 prior to exposure. The number of lymphocytes decreased even more quickly and reached a minimum 24 hr after irradiation. Patho-anatomical changes were found in lungs, skin, spleen, and lymphatic ducts. (H.B.G.)

4682 HISTOLOGICAL AND HISTOCHEMICAL OBSERVATIONS OF THE MEGAKARYOCYTE FOLLOWING IONIZING X IRRADIATION. Amler, Melvin H.; Robinson, Harry L. (New York Univ., N. Y.). Exp. Med. Surg., 26: 30-9(1968).

Megakaryocytes were studied in rats receiving total doses of 300, 600, 900, 1200, 1500, and 1800 R of x radiation. The mortality rates 3 days after these doses were 17, 40, 67, 75, 83, and 96%, respectively. Two aspects of bone marrow cellular changes found in Hodgkin's disease were duplicated here by irradiation. First, megakaryocyte hyperplasia occurred following a cumulative dose of 600 R. Second, a basic-staining nucleus as well as basichromatin and parachromatin (usually present in Reed–Sternberg cells) could be observed in megakaryocyte nuclei following a cumulative dose of 900 R. The basic staining reaction of the nucleus was presumably explained by the liberation of free nucleic acids as a result of irradiations. The nucleic acid was RNA since it could be abolished by incubation in RNAse, but not by DNAse. Certain histochemical aspects of the megakaryocytes were unaltered by irradiation. Metachromasia of the cytoplasm in all stages of irradiation was removed by hyaluronidase, indicating that intracytoplasmic mucopolysaccharides remained unaltered as hyaluronic acid. No diminution of the PAS-positive reaction in the cytoplasm was noted at all 6 stages, from 300 to 1800 R. (BBB)

4683 EXPERIMENTAL STUDY OF AEROSOL INFECTION WITH TULAREMIA UNDER CONDITIONS OF A LESION PRODUCED BY IRRADIATION WITH X-RAYS. Sumnaliev, M. Voenno Med. Delo, 24: No. 2, 45-50(1969). (In Bulgarian).

White rats irradiated with x-rays in a dose of 450 or 650 R were infected with tularemia by means of an aerosol with particle size $\leqq 2\ \mu$ prepared from a culture of the virulent strain Sreburna 19 of *Francisella tularensis palearctica*. Infection was carried out at 20° and a relative humidity of 80%. On the basis of data on the lethality, LD_{50} and DCL in terms of the number of bacterial cells and also the index of resistance to the infection were determined. The latter decreased to 0.01 and 0.001 on irradiation with 450 and 650 R, respectively, from 1 for control animals that had not been irradiated. A microbiological study of the dynamics of development of the infection process on infection with 60 and 6000 bacterial cells following irradiation with 450 R showed that the rate of development of infection was increased vs. that for nonirradiated control animals and that, the stage of resistance to the infection was absent. Table, graphs, and figures, 14 references (2 Bulgarian, 5 USSR, 7 Western). (JPRS)

4684 REDUCED PLATELET ADHESIVENESS AFTER WHOLE-BODY X-IRRADIATION. Kagnoff, M. F. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Int. J. Radiat. Biol.; 15: 587-590(1969).

Platelet adhesiveness, platelet count, white blood-cell count and haematocrit were determined for each dog on 5 days during the week preceding irradiation as well as 4 hours prior to exposure. Similarly, values were determined 1 hour after exposure as well as on days 1, 2, 3, 4, 7, 8, 9, 11, 14, 15, 17, 21, 22, 25, 28, 30, 32, 35, and 37 after irradiation. Student's t test was used to measure statistical significance. X irradiation was performed with a radial beam generator: 250 kVp; 30 mA, total filtration 1.2 mm Be (inherent) and 0.95 mm Cu (added), h.v.l. 1.9 mm Cu. Platelet adhesiveness in every dog showed a marked decrease after exposure and was followed by complete recovery. (UK)

4685 THE EFFECT OF RADIATION ON THE GROWTH OF VERTEBRAE IN THE TAILS OF RATS. III. THE RESPONSE TO CYCLOTRON NEUTRONS. Dixon, B. (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 15: 541-8(1969).

Vertebrae in the tails of young rats have been irradiated with single doses of cylotron neutrons under reduced ("anoxic"), normal and increased conditions of oxygenation. Oxygen is dose-modifying with neutrons. The oxygen-enhancement ratio is 1.44 (±0.04) for single doses given in air. The RBE of neutrons decreases with increasing dose, and it is suggested that the neutron survival curve for epiphyseal cells in situ is exponential. This is consistent with the failure to obtain a significant sparing effect by fractionation of neutron doses given to rats breathing air. (auth) (UK)

4686 EFFECT OF GAMMA RADIATION ON THE BACTERICIDAL LYSOSOMAL FACTORS IN LEUKOCYTES. Prixova, Jitka. Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, 11: Suppl., 287-95(1968). (In Czech).

Experiments showed that total-body irradiation of rabbits with gamma rays in a dose of 1000 R induced damage to intracellular bactericidal mechanisms. Reparation occurs within 28 days following irradiation, which is in correlation with normalization of blood formation in the bone marrow. The damage is probably related to a disturbance in the maturation of cytoplasmic granules which are a reservoir of biologically active substances. (auth)

4687 INFLUENCE OF LOW-DOSE X RADIATION ON THE DEVELOPMENT AND GROWTH OF THE BRAIN. Kameyama, Yoshiro; Hoshino, Kiyoshi (Nagoya Univ., Japan). Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ., No. 16, 43-9(1968).

The ddN mice were subjected to single whole-body x radiation of 25 or 50 R on day 15, 16, 17, or 18 of pregnancy. The offspring (exposed in utero) were killed 20 days, 40 days, or 6 months after birth, and their cerebral cortices were examined microscopically. Deviations from the normal cytoarchitecture of the neocortex such as a sparsity of neurons, poorly delineated laminations and an irregular arrangement of the neurons were observed in the 25 R group. These changes were dominant in the inner layers in the group irradiated on day 15 or 16 of pregnancy, while the changes tended to be localized in the outer layers in the group irradiated on day 18. Such changes were reduced as the animals grew older, and the process of reduction seemed to be faster in the group irradiated on day 15 or 16 than that irradiated on day 18. The abnormalities of the 50 R group showed the same patterns of disturbance of neuronal organization of the cortex as those of the 25 R group. A deficit of neurons and an increase of glia were also observed in some cases in the 50 R group. The deviation of the cortical architecture and a deficit of neurons due to 50 R were still detected 6 months after birth. (TSS) (NSA of Japan)

4688 COMBINED EFFECT OF X-RAY IRRADIATION AND MICROWAVES ON BONE MARROW. Sevat'yanova, L. A.; Potapov, S. L.; Adamenko, V. G.; Vilenskaya, R. L. (Inst. of Experimental and Clinical Oncology, Moscow. Scientific-Research Inst.

of the Ministry of Electronic Industry, Moscow). Biol. Nauki, No. 6, 46-8(1969). (In Russian).

Male mice, 32 grams in weight, were divided into four groups: nonirradiated (control) animals; irradiated animals; animals irradiated with microwaves in the millimeter range followed by x-irradiation; animals subjected to x irradiation and subsequently to microwave irradiation. The right hip was the part irradiated. Microwave irradiation was accomplished using a type OV 60012 lamp with a range of 5.7 to 8.0 millimeters; x irradiation was carried out with the TUM-7 apparatus in doses of 700, 1,400, and 2,100 Rads. Within 3 and 6 hours and 1, 2, 3, and 5 24-hour periods after irradiation the total number of nucleus-containing cells in the right irradiated and left nonirradiated hips was determined; the number of leukocytes in the peripheral blood was determined for the first and third 24-hour periods after the irradiation. The investigations established that the preliminary irradiation with microwaves tends to attenuate the action of x irradiation. (JPRS)

4689 THE INFLUENCE OF AMINAZINE ON THE VESTIBULAR REFLEXES IN RABBITS. Kvasnikova, L. N. Vestn. Otorino-Laringol., 28: 35-9(Nov.-Dec. 1966). (In Russian).

Aminazine (1 mg/kg) significantly suppresses or completely eliminates the vestibulovegetative reactions and intensifies somewhat the vestibulosomatic reactions to an adequate stimulation of the semicircular canals. The referred to correlations are preserved after the administration of aminazine at early periods following total gamma irradiation in a dose of 500 R against the background of weakening of the vestibulovegetative and vestibulosomatic reactions caused by the radiation effect. In view of the adrenolytic action of aminazine, prevalently on the reticular formation of the brain stem, it is supposed that the latter participates in the formation of vestibular reactions, both somatic and vegetative. (auth)

4690 EFFECT OF RADIATION OF AN OPTICAL QUANTUM GENERATOR (LASER) ON THE ELECTRIC CONDUCTIVITY OF THE ANIMAL LIVER. Sidorik, E. P.; Danko, M. I.; Nikitchenko, V. V. (Kiev Inst. of Scientific-Research in Experimental and Clinical Oncology). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 8, 738-41(Sept. 1969). (In Russian).

The radiation of optical quantum generators (lasers), characterized by coherence, monochromaticity and the possibility of creating a high energy density on a small area provokes primary and secondary effects when interacting with the biological tissues. Investigations were carried out on the determination of the electrical parameters of the liver under conditions of radiation effect of a neodymium laser with energy in the pulse of 250 joules. Dependences are investigated of the resistivity, the dielectric constant and the tangent of the angle of loss on the current frequency at various periods after irradiation. A correlation has been established between the changes in the electric parameters and the gravity of the liver lesion subjected to irradiation by laser. (auth)

4691 POSTIRRADIATION CHANGES IN ULTRASTRUCTURE AND ENZYME CYTOCHEMISTRY OF RAT THYMUS. Toero, I.; Bacsy, E.; Oekroes, I.; Vadasz, Gy.; Rappay, Gy. (Inst. of Experimental Medicine, Budapest). Acta Med. Acad. Sci. Hung., 25: 355-66(1968).

Cytochemical changes induced in the rat thymus by sublethal irradiation were studied by light and electron microscopy and starch-gel electrophoresis. A 450-R dose of 180-kV x rays was used. Thymus reticular cells exhibited different acid phosphatase and nonspecific esterase activity ratios. These ratios were not affected by irradiation, though the intensity of the individual activities increased. Starch-gel electrophoresis showed that irradiation affected the isozyme spectrum of the thymus qualitatively as well as quantitatively. Electron microscopic studies revealed that the dense bodies of the mesenchymal reticulum as well as the moniliform material of the epithelial reticulum are sites of acid phosphatase activity and, therefore, identifiable as lysosomes. Mesenchymal reticular cells accumulated large amounts of lipid after irradiation. Massive cell breakdown and metabolic transformation of the cellular debris would account for this finding. Additional factors, such as irradiation stimulation of the activity of the pituitary-adrenocortical system may be involved in lipid accumulation. The fact that the two hydrolytic enzymes are not present in the same ratio in the reticular cells of the normal thymus, and that this discrepancy was demonstrable after irradiation and during massive phagocytosis, suggests that the different enzyme concentrations represent different kinds of cell rather than different functional phases of the same cell type. (BBB)

Man

Refer also to abstracts 4638, 4651, 4660, 4662, 4667, and 4669.

4692 AN ABSCOPAL EFFECT IN MALIGNANT LYMPHOMA AND ITS RELATIONSHIP TO LYMPHOCYTE CIRCULATION. Nobler, Myron P. (Beth Israel Medical Center, New York. Mt. Sinai School of Medicine, New York). Radiology, 93: 410-12(Aug. 1969).

A case is reported in which a patient with a diagnosis of malignant lymphoma manifested an abscopal response of an unusual magnitude. Recent information outlining the circulatory pathways of lymphocytes throughout the body has been summarized. The presently accepted concepts of lymphocyte circulation have been applied to the abscopal reaction in the case reported, and the interrelationship between disappearance of bilateral pleural effusions and irradiation of the retroperitoneal para-aortic and pelvic lymph nodes has been clearly established. (auth)

4693 ON THE MECHANISM OF ACTION ON THE NERVOUS SYSTEM OF INCORPORATED SHORT-LIVED RADIOACTIVE SUBSTANCES. Panov, A. G.; Ulitovskii, D. A. Klin. Med. (Moscow), 46: 92-6(Sept. 1968). (In Russian).

An analysis of neurogenic factors may be successful only in an accurate evaluation of the intensity of radiation action on different organs and tissues, especially in respect to incorporated isotopes. On the basis of dosimetric data, the mechanism of action on the nervous system of isotopes having the greatest clinical importance, ^{198}Au, ^{131}I, and ^{32}P is discussed. Dosimetric data and consideration of the mechanisms of neurological disorders, serve as a basis for the pathogenic classification of lesions by the isotopes discussed. (C.O.)

4694 HYPOTHYROIDISM AFTER TREATMENT WITH SODIUM IODIDE ^{131}I. Burke, Gerald; Silverstein, Gerald E. (Michael Reese Hospital and Medical Center, Chicago). J. Amer. Med. Ass., 210: 1051-8(Nov. 10, 1969).

Treatment of hyperthyroidism with sodium iodide ^{131}I has been implicated as a stimulus to long-acting thyroid stimulator (LATS) production and opthalmopathy. To evaluate this postulate, data of 484 thyrotoxic patients treated with this drug have been reviewed. The incidences of hypothyroidism at one, five, and eight years were 31%, 44%, and 54%, respectively. Of 94 patients with ophthalmopathy, only 19 showed exacerbation unrelated to posttherapy thyroid function after treatment with sodium iodide ^{131}I. In the serum of 25 to 60 patients, LATS was detected, but no evidence of ^{131}I-induced LATS formation was seen six weeks to 30 months after treatment. However, elevated antithyroid-antibody titers were noted within six months of treatment, particularly in patients in whom hypothyroidism was developing. There was no correlation between LATS and ophthalmopathy or between LATS and antithyroid antibodies. These data indicate that LATS formation does not result from thyroid injury, but suggest that hypothyroidism which develops after treatment with sodium iodide ^{131}I is a manifestation of thyroid autoimmune disease. (auth)

4695 RESULTS OF THERAPY OF THYROTOXICOSIS WITH RADIOACTIVE IODINE FROM THE POINT OF VIEW OF COMPLICATIONS AND DOSIMETRY. Rohling, S.; Nemec, J.; Silink, K.; Vohnout, S. (Endocrinological Research Inst., Prague). Cas. Lek. Cesk., 108: 1043-9(Aug. 15, 1969). (In Czech).

The main disadvantage to the use of radioactive iodine therapy is the danger of a resulting hypothyrosis. The greatest risk in the treatment with radioactive iodine is for young people, pregnant women, and patients with light forms of thyrotoxicosis. Patients younger than 45 and those with nodular struma should be treated surgically. Patients with cardiac affections and with other serious diseases should be treated with radioactive iodine, not surgically. Every patient should be first brought to a condition of euthyrosis before a decision is made how to treat his hyperthyroid condition. (JPRS)

4696 SOME PROBLEMS CONCERNING THE EFFECT OF IRRADIATION OF THE DIENCEPHALO-HYPOPHYSIAL AREA IN ITS PATHOLOGY, UPON THE ENDOCRINE GLANDS. Draznin, N. M.; Bril, E. E.; Livshits, I. B.; Martyanova, L. Ya.; Radyuk, K. A. (Inst of Nuclear Power, Minsk. Belorussian Inst. for Graduate Medical Studies, Minsk). Probl. Endokrinol., 15: No. 3, 33-7(May-June 1969). (In Russian).

The adrenocorticotropic activity of the blood plasma, blood 17-oxycorticosteroids, functional condition of the thyroid gland, and free and bound blood insulin in patients with acromegaly and Itsenko–Cushing's disease were examined. Investigations were carried out before and on the 1st and 2nd day after x-ray therapy of the diencephalo-hypophysial area. There was a marked fall of plasma adrenocorticotropic activity in both groups of patients, and following irradiation in cases of Itsenko–Cushing's disease. X irradiation caused a fall of the blood 17-oxycorticosteroids. There was some rise in the indices of the functional activity of the thyroid gland; a tendency of the fractions of bound and free blood insulin to rise was noted in both groups of patients. (auth)

Radiation Effects on Plants

Refer also to abstracts 4563, 4573, 4596, 4597, 4601, 4602, and 4608.

4697 DIFFERENTIAL SENSITIVITIES TO GAMMA RADIATION OF PHYLLOXERA GALL AND NORMAL GRAPE STEM CELLS IN TISSUE CULTURE. Arya, H. C.; Hildebrandt, A. C. (Univ. of Wisconsin, Madison). Can. J. Bot.; 47: 1623-8(Oct 1969).

The differential responses were observed of cells for tissue cultures of normal grape stem (GS6-24) and *Phylloxera vastatrix* Planch. leaf gall (GP4-21) exposed to gamma radiation of 100 to 500,000 R from cobalt-60. The percentage survival of cells decreased with increased intensity of radiation. The mitochondria, spherosomes, and nucleus were visibly affected by radiation. The percentage survival of gall cells was lower than that of normal cells after exposure to the same radiation intensity. The irradiated cells did not recover regeneration even when exposed to the smallest dose of 100 R, though a certain percentage of cells survived during 28 days of observation. The effectiveness of 2-mercaptoethylamine hydrochloride (MEA), and 2-aminoethylisothiouronium bromide hydrobromide (AET) at 1×10^{-2} to 1×10^{-6} M in protecting the cells against gamma radiation was tested by incorporating them in liquid medium containing actively growing cells of normal and gall types. Observation of cells in microcultures exposed to 1000 R showed that MEA at 1×10^{-4} M and AET at 1×10^{-3} M decreased the lethality of radiation to normal grape cells considerably more than to the gall cells. The normal cells treated with 1×10^{-3} M AET and exposed to 1000-R radiation also divided. (auth) (Canada)

4698 PHOTOPROTECTIVE EFFECT OF THE PIGMENT OF NADSONIELLA NIGRA. Lyakh, S. P.; Ruban, E. L. (Inst. of Microbiology, Moscow). Microbiology (USSR) (Engl. Transl.), 3: 721-3(Sept.-Oct. 1969).

X irradiation with 250 R yielded a mutant (1-305) of *Nadsoniella nigra* strain 365 that synthesized an extracellular pigment when cultured on a medium containing glucose and yeast autolyzate. Aqueous solutions of the pigment (in both the unirradiated and irradiated forms) were nontoxic for *Candida utilis* 295 and completely protected cells of this radiosensitive strain against the lethal effect of uv radiation at a concentration of 0.15%. The photoprotective effect disappeared when the pigment content of the solution was reduced to 0.0015%. It was shown that the pigment protected the cells only at the time of irradiation. Transfer of irradiated cells to water immediately after exposure to uv light in pigment solutions (unirradiated and irradiated) did not raise their survival rate. This indicates that the pigment could not ameliorate lethal cell damage during the postirradiation period. The mechanism of the protective effect of the pigment is discussed. Presumably it acts by absorption of the uv light. The pigment has a pronounced capacity for light absorption over a broad region of the uv spectrum. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 4573, 4600, 4603, 4701, 4704, and 4705.

4699 (TID-25179) STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION, AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B, AND E. Progress Report. Graikoski, J. T.; Kempe, L. L. (Michigan Univ., Ann Arbor. Dept. of Chemical and Metallurgical Engineering). June 1963. Contract AT(11-1)-1095. 47p. Dep. CFSTI.

Six representative strains of *Clostridium botulinum* Type E are being used along with strains obtained from Japan, Sweden, and Denmark to determine whether marked physiological differences occur among the strains of different origins. Growth and toxin production in haddock homogenates and broth were studied with incubation at temperatures between 0 to 37°C. At 37.5°C, 33.0°C, and 18.0°C, growth occurred within three days. At 8.3°C, and with some strains at 5.4°C and 3.3°C, growth as measured by gas production was variable. However, low levels of toxin were detected in the samples within 38 days of incubation. At 0°C, no growth occurred in any of the samples after 138 days of incubation. Activation of the cultures with trypsin was necessary in order to detect low levels of toxin in the filtrates. Resistance of the spores of the six strains of Type E to γ radiation in phosphate buffer was found to be similar. Irradiation of the spores in haddock homogenate and oyster juice resulted in an increase in survivors that was 100 to 1000 greater than the increase resulting from irradiation under similar conditions in buffer. (auth)

4700 THE RESPONSE OF ALBINO RATS TO INFECTION WITH IRRADIATED AND NON-IRRADIATED METACERCARIAE OF FASCIOLA HEPATICA. Sokolic, A.; Sofrenovic, D.; Sibalic, S.; Cuperlovic, K.; Dordevic, Milanka; Lepojev, Olga (Inst. for Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Acta Vet. (Belgrade); 18: 187-201(1969). (In Slovak).

Rats were infected with *Fasciola hepatica* that were either normal or irradiated. Apparently, radiation decreased the infection rate. Histologically, liver damage showed no difference between irradiated and normal flukes. Immunologic procedures proved to be most effective for detecting infection. (H.B.G.)

Radiosterilization and Radiopreservation

Refer also to abstracts 4595, 4675, and 4699.

4701 (NYO-3733-3) MICROBIOLOGICAL ASPECTS OF RADIOPASTEURIZED CHICKEN. Third Quarterly Report. (Hazleton Labs., Inc., Falls Church, Va.). Aug. 1967. Contract AT(30-1)-3733. 38p. Dep. CFSTI.

The research objectives and the experimental design and results to date (July 1967) for this phase of the continuing study of the microbiological aspects of radiopasteurized chicken are presented. The research objectives during the time reported included the development of techniques to recover all microbial species from a piece of chicken with subsequent suspension in a liquid medium, to permit growth of each microbial type in a selective or differential medium to a level equivalent to that which would occur in reference medium, and to determine quantitatively the population density of each microbial type in a mixture of such cells. The progress obtained in the detailed examination of each of these objectives experimentally is given. (E.R.B.)

4702 (NYO-3740-4) DEMONSTRATIONS CONDUCTED BY THE PORTABLE CESIUM IRRADIATOR DURING THE PERIOD SEPTEMBER 30, 1967–DECEMBER 19, 1968 AND OPERATION OF THE PORTABLE CESIUM IRRADIATOR REPORT FOR PERIOD AUGUST 11, 1967–JUNE 30, 1969. Grant, W. B.; Sine, L. M. Jr.; Erlebach, W. E. (Isotopes, Inc., Westwood, N. J.). July 1, 1969. Contract AT(30-1)-3740. 77p. (NYO-3740-5). Dep. CFSTI.

The demonstration program of the Portable Cesium Irradiator is summarized. Operated under contract by Isotopes, Incorporated for the Federal Government in support of the USAEC Food Irradiation Program, the Irradiator was made available to interested food processors and other interested industrial concerns for onsite irradiation of products of interest to these companies. A wide variety of foods and commercial products were irradiated during the report period. A brief summary is given of each demonstration including location, user, test description and results, irradiator operation, and evaluation of company response. A program summary and purpose are given as well as a description of the Irradiator and data on scheduling, operation, modifications, and overhaul of the portable facility. (E.R.B.)

4703 (ORNL-IIC-26) MILK PRESERVATION BY IONIZING RADIATION: LITERATURE REVIEW. Gerrard, Martha (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 15p. Dep. CFSTI.

Brief discussions are presented of results obtained by various workers on radiation doses necessary for pasteurization, sterilization, and inactivation of enzymes in milk. Results of work on dose variation with species of bacteria found in milk are reviewed. Effects of radiation on wholesomeness, vitamin content, nutritive value, and organoleptic and physical properties are discussed. It is concluded that radiation processing of milk to increase its storage life is not yet a promising technique. A list of 55 references is included. (H.L.W.)

4704 (TID-25142) APPLICATION OF RADIATION-PASTEURIZATION PROCESSES TO PACIFIC COAST FISHERY PRODUCTS. Annual Report, November 1, 1967–October 31, 1968. Miyauchi, David; Teeny, Fuda; Pelroy, Gretchen (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Nov 1968. Contract AT(49-11)-2058. 105p. Dep. CFSTI.

Research was directed toward having certain selected radiation-processed seafood products cleared by the Federal Drug Administration and advancing the process to the point of commercialization. The benefits of irradiating fish at sea before significant changes in the quality of fish occur and while the number of spoilage bacteria are at their lowest levels were investigated. A series of experiments was completed on five species of fish, including Pacific Ocean perch, black rockfish, cod, English sole, and Dover sole caught off the coast of Washington and irradiated at sea. A schematic sketch of the γ shipboard irradiator is included. The various species of fish were irradiated at doses up to 200 kiloRads in the shipboard irradiator during prerigor (0 to 3 hr after catch), rigor (6 to 24 hr after catch), or postrigor (2 to 8 days after catch). Throughout the tests, the fish were stored at 33°F. Sensory evaluations were made at periodic intervals on the whole fish and on the raw and cooked fillets. The results showed that the optimum radiation dose for suitable postirradiation storage for Pacific Ocean perch, black rockfish, English and Dover sole, and cod is in the range of 50 to 100 kiloRads. The chilled irradiated fish had significantly better storage characteristics than their nonirradiated counterparts. No significant differences were observed in the storage characteristics of fish irradiated prerigor and of fish irradiated while in rigor; both groups of fish had significantly better storage characteristics than the nonirradiated control samples. Results also showed that fish irradiated at sea and stored in the round should be processed into fillets within 2 weeks since longer storage periods cause a lowering of quality from autolysis and discoloration of the flesh. A study was conducted to establish whether or not radiopasteurized fish, if mishandled, are hazardous with respect to Clostridium botulinum type E by relating the maximum edible shelf life (X-value) as determined by odor alone of a product with the minimum time for toxin production for intentionally heavily inoculated samples of fish similarly stored. The X-values were also determined for English sole fillets irradiated at 0, 100, and 200 kiloRads and stored at 38, 42, and 46°F and for Dover sole fillets irradiated at 0, 100, and 200 kiloRads and stored at 42 and 46°F. Simultaneously, toxin production was determined in correspondingly stored fillets which were inoculated with spores of C. botulinum type E and irradiated under Dr. Melvin Eklund's contract. The results of these studies showed the X-values were shorter than the earliest toxin-production time with the exception of Dover sole fillets irradiated at 200 kiloRads and stored at 46°F. (C.H.)

4705 (TID-25232) TOXICOGENESIS IN IRRADIATED ATLANTIC COD AND FLOUNDER AT LOW STORAGE TEMPERATURES. Annual Report, 1968. Graikoski, John T. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Nov 1969. Contract AT(49-7)-3006. 15p. Dep. CFSTI.

Toxin production was determined in radiation pasteurized Atlantic cod, which had been previously inoculated with type E spores of the beluga strain of Clostridium botulinum. The fish were stored at 10°C (50°F), 7°C (44.6°F), and 3°C (37.4°F). Concurrently, the time of spoilage of the fish were determined by sensory evaluation and microbial plate counts. Results to date with Atlantic cod show that toxin can be detected in γ irradiated fish (100 and 200 kiloRad level) within three to six days at 10°C. At the 7°C, storage temperature toxin was detected in the fish fillets after 15 days of storage, but only in fish irradiated to the 200 kiloRad level. At 3°C none of the fish tested contained toxin after 34 days of storage. In other experiments comparing the ability of various fish species to support growth and toxin production, results showed that Atlantic cod and haddock are relatively poorer substrates in this regard than freshwater yellow perch and flounder. (auth)

4706 STUDIES ON THE CONTROL OF DACUS CILIATUS LOEW [TEPHRITIDAE:DIPTERA] BY STERILE MALE RELEASE TECHNIQUE. Huque, Heshamul; Ahamd, Chaudhry Riaz (Radioisotope and Radiation Lab., Karachi, Pakistan). Int. J. Appl. Radiat. Isotop.; 20: 791-5(Nov 1969).

The effect of gamma radiation from a cobalt-60 source on adults of the fruit fly (Dacus ciliatus Loew) following pupal exposure was determined. When 7 day old pupae were irradiated at 5 krad partial sterility with normal longevity was observed in the adults, while irradiation at doses of 8.5 and 10 krad induced complete sterility with normal longevity and preoviposition period which lasted throughout their adult life. The optimum sterilizing dose for this fly thus lies in the range of 8.5–10 krad and can be effectively utilized for the eradication of this fly from the Karachi area by sterile male release method. (auth) (UK)

4707 STERILIZATION OF BOLL WEEVILS WITH COMBINATIONS OF CHEMOSTERILANTS AND X-RAYS, GAMMA RAYS, THERMAL NEUTRONS, OR FAST NEUTRONS. Klassen, W. (Dept. of Agriculture, Fargo, N. Dak.).; Norland, J. F.; Briggs, R. W. J. Econ. Entomol., 62: 1204-16(Oct. 1969).

This study was undertaken to determine whether satisfactory sterility without mortality could be induced in Anthonomus grandis Boheman. Adult boll weevils irradiated with 2.5 krad of x rays and immersed in a 1.0% solution of apholate within 8 hr had a greater cumulative percentage mortality at 3 weeks than when the two treatments were separated by several days. However, the treatments failed to destroy completely the germarium in all males. Destruction of the germarium occurred more frequently if the males were still soft bodied when they were immersed. Thus, when 2-day-old males were immersed in apholate and x-irradiated 80 hr later, the majority sustained permanent destruction of the germarium. Weevils treated with 2.5 krad of γ rays and a 1.0% solution of apholate reestablished the spermatogenic cycle as early as 13 days later and usually within 3 weeks; in one test, recovery of fertility occurred 11 to 13 days after treatment, and in two other tests, recovery occurred at 14 to 16 days after treatment. Sublethal doses of thermal neutrons did not sterilize boll weevils, but 1 krad of fast neutrons significantly reduced the fertility of treated males and the fecundity of treated females. Doses of fast neutrons greater than 1.2 krad caused high mortality, but a dose of 2 krad was necessary to sterilize all sperm and destroy all spermatogonia. Fecundity of treated females was greatly reduced with 1.5 and 2 krad. However, their fertility was depressed only moderately. Irradiation of either sex with 1 krad of fast neutrons and immersion 3 days later in a 1.0% solution of apholate resulted in almost complete sterility, though the spermatogenic cycle was re-established in some individuals at 4 weeks after treatment. Moreover, this treatment reduced mating competitiveness of males treated as adults less than treatment with 2.5 krad γ rays and a 1.0% solution of apholate. (auth)

4708 THE EFFECT OF IRRADIATED FOOD RATIONS WITH PASTEURIZING DOSES OF GAMMA-RADIATION ON THE ALBINO RAT. Shillinger, Yu. I.; Kachkova, V. G.; Kamal'dinova, E. M. Vop. Pitan., 26: 72-8(May-June 1967). (In Russian).

In chronic experiments on 5 generations of albino rats, the effect produced by a ration of a number of products treated with different doses of gamma-radiation (meat, oats, grits and potatoes) was investigated. A long-term feeding (8 to 10 months) of irradiated products did not exert any visible influence on the laboratory animals. An unfavorable effect on the reproduction function was noted, expressed as lengthening of the term of the first delivery and a tendency towards reduced survival of the progeny in the first month of life. A certain increase in the incidence of intercurrent diseases (pneumonia) was recorded in experimental rats, as compared to control animals. (auth)

4709 INNOCUOUSNESS OF IRRADIATED FOOD PRODUCTS: THEIR CONTROL AND IDENTIFICATION AS WELL AS LEGISLATION RELATIVE TO THEIR UTILIZATION. Bugyaki, L. (Institut d'Hygiene et d'Epidemiologie, Brussels). J. Belge Radiol., 52: I-X(1969). (In French).

Problems arising from preserving food by irradiation are examined, particularly radioactivity induced by radiations, the chemical and microbiological toxicity of irradiated foods, and their nutritive value and edibility. The status of legislation in various countries regarding this method of preservation is reviewed. (C.O.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 4209 and 4400.

4710 (ORNL-4440) FUELS AND MATERIALS DEVELOPMENT PROGRAM. Quarterly Progress Report for Period Ending June 30, 1969. Patriarca, P. (comp.); Rucker, D. J. (ed.) (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 254p. Dep. CFSTI.

Fuels research and development activities are reported in fifteen sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 4414, 4717, 4734–4738, 4771, 4827–4829, and 4857–4859.

4711 HIGH TEMPERATURE MATERIALS. Sixth Plansee Seminar, June 24–28, 1968, Reutte/Tyrol, Austria. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. 1099p. (In several languages). (CONF-680603).

Sixty-three papers were presented at the Sixth Plansee Seminar. Abstracts for five papers appeared previously in NSA, and separate abstracts were prepared for fifty-two of the remaining papers. (D.H.M.)

For abstracts of individual papers see: 4210–4213, 4415, 4712, 4722–4732, 4747–4760, 4793–4803, 4811–4813, 4836–4838, 4846–4848, and 4853.

4712 CONFIGURATION MODEL OF LOCALIZED VALENCE ELECTRONS. Samsonov, G. V. pp 10-27 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The configuration localization model, whose characteristics are described, permits a representation of the nature of the processes occurring in the formation of compounds in general and of high melting compounds in particular. The nature of the properties of simple substances and compounds can also be represented by the model. Although these representations are of a qualitative or semi-quantitative type, they can facilitate the synthesis of materials with desired properties and shorten the necessary experimental verifications. On this basis the model has advantages in the solution of problems which are concerned with the development of new materials or the improvement of known materials for new purposes. (tr-auth)

Corrosion and Erosion

Refer also to abstracts 4398 and 4754.

4713 (BNWL-1184) CORROSION PRODUCT STUDY BY SCANNING ELECTRON MICROSCOPE. Kabele, T. J.; Daniel, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 69p. Dep. CFSTI.

Changes in the form and composition of the corrosion products on the surfaces of four typical N-Reactor materials as functions of time and coolant flow rate were observed using a scanning electron microscope. Zircaloy-2, Inconel, 304-stainless steel, and mild steel coupons were exposed to deionized, deoxygenated, pH-10 ammonia water at 280°C and 1000 psi. Exposures were one hour to nine weeks at flow rates from zero to 30 ft/sec. A great variety of corrosion products (both in form and composition) was observed. A detailed description of these corrosion products is presented along with micrographs and x-ray spectrograph data. (auth)

4714 (BNWL-1192) A CRITICAL REVIEW OF STRESS-CORROSION CRACKING AS ASSOCIATED WITH THE FFTF DRIVER FUEL CLADDING. Bowersock, R. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

A review of the literature pertaining to stress corrosion of austenitic stainless steel was made. This review failed to reveal either a threshold concentration level required to induce stress corrosion or specific information on how halides are attached to the metal surface. Applicable process specifications and analytical procedures for the determination of residual halide were reviewed and found to be responsive to the needs of the Fast Flux Test Facility. (auth)

4715 (N-69-36804) SILICIDE COATINGS FOR TANTALUM AND COLUMBIUM ALLOYS. Final Summary Report, April 1, 1967–December 31, 1968. Shoemaker, H. E.; Stetson, A. R. (Solar, San Diego, Calif.). Aug. 1969. Contract NAS3-9412. 183p. (NASA-CR-72519; RDR-1557-2). CFSTI.

Twenty-six variations of silicided Mo-W-Ti-V modifier alloys were investigated for their ability to protect the T222 tantalum-base alloy. From this group, selected coatings were tested for their protection of the niobium base alloy FS-85. The 20Mo50W-15Ti15V modifier alloy yielded a silicide coating that provided protection in cyclic furnace oxidation for more than 800 hours at 2400°F, after ballistic impact at 170 ft/sec for 10 hours at 1600 and 2400°F, during 22 slow thermal cycles to 2300°F, and in oxidation-erosion rig tests at Mach 0.85 and 2400°F for over 200 hours. The standard procedure for the duplex coating application throughout the program included slurry spraying of metallic elements and hydrides and vacuum sintering, which was followed with siliciding by pack cementation. To optimize the coating process, dip slurries were developed. The dip coatings provided less protection than those applied by spray techniques, but indicated the potential for development to provide equal or superior protection. Difficulties were encountered in obtaining protection of internal surfaces using the dip coating techniques. (auth) (STAR)

4716 (NP-tr-1866) DIFFUSION CLADDING OF METALS. Samsonov, G. V. (ed.). Translation of Diffuzionnye Pokrytiva na Metallakh, Kiev, Naukova Dumka, 1965. 89p.

A collection of papers relating to the diffusion saturation of metals and to coatings of refractory compounds is presented. Current problems in the theory and practice of the production of diffusion coatings on metallic materials are discussed. A means of classifying the methods of diffusion saturation is proposed, and a new method is described for calculating the diffusion parameters in a heterogeneous medium. Sixteen papers are included. (J.R.D.)

4717 (ORNL-4440, pp 75-108) ALKALI-METAL CORROSION STUDIES. Harms, W. O.; DeVan, J. H.; Litman, A. P. (Oak Ridge National Lab., Tenn.).

Effects of O in Na on its compatibility with V were evaluated in capsule tests at 600°C. In type 304 stainless steel containers, essentially all of the O initially in the Na (up to 4000 ppM) was gettered by the V. The ratio of O in V to Na at equilibrium was greater than 10^4. In Mo containers, the percentage of O gettered from Na by V decreased with increasing O concentration in the Na. This apparently resulted from mass transfer of Mo or Fe and Ni from the mass transfer of Mo or Fe and Ni from the capsules to the V. A thermal convection loop test with a ratio of 0.24 between the surface areas of V and stainless steel has operated 1700 hr. Vanadium specimens from dissimilar-alloy static capsule tests of type 304L stainless steel and V showed weight gains and darkened surfaces after 500 hr at 800°C. To evaluate the effect of interstitial contamination of V and its alloys on mechanical properties, an apparatus has been designed to obtain creep data under controlled environments. In the range 10^{-5} to 10^{-7} torr, no pick-up of C or N by V was found but O increased at 6×10^{-6} torr and higher. Contamination can be prevented at 1.6×10^{-5} torr by wrapping the specimens with Ta foil. In a study of the oxidation of V from 410 to 890°C, the maximum rate occurred at 550°C at both 2×10^{-7} and 2×10^{-6} torr O_2 pressure. Compatibility of thermal insulation with stainless steels in dry and moist air was tested. There is little effect of contact with insulation on the scaling of either type 304L or 316 stainless steel up to 760°C. The amount of O in Li does not measurably affect the amount of Nb or Ta that will dissolve in it; however, the amount of Nb or Ta that dissolves in K or Na is highly dependent on the O initially in the liquid metal. On the other hand, when Nb or Ta contains O, attack by Li is much more severe and occurs at lower O concentrations than with either Na or K. To determine the influence of stainless steel components on the partitioning of O between Zr and Na, static capsule tests were conducted at 815°C. In all the tests, the Zr specimens exhibited a surface deposit that increased with increasing O in Na, and chemical results indicated that Fe, Mn, C, O, N, and H had transferred from the stainless steel to the Zr. This caused a decrease in the percentage of O recovered by the Zr as the O concentration of the Na increased. When compared with those from either hotter or cooler regions, T-222 bend specimens from the intermediate temperature zone (1220 to 1280°C) of a T-222 thermal convection loop that circulated Li for 3000 hr at 1350°C were relatively brittle. Although the N content of these samples had increased slightly during the Li exposure, no significant concentration gradients were found in the specimens. (auth)

4718 THE DISSOLUTION OF METAL CORROSION PRODUCTS IN DEIONIZED WATER AT 38°C (100°F). Johnson, Barbara A. (Lewis Research Center, Cleveland). Nucl. Appl. Technol.; 8: 58-61(Jan 1970).

The dissolution of the corrosion products of metals in deionized water at 38°C (100°F) is discussed. Copper, tungsten, cadmium, and Mallory-1000 give soluble corrosion products. Mention is made of 304 stainless steel, 1100 aluminum, titanium, tantalum, silver, and boron steel, all of which showed no soluble corrosion products. The significance of soluble corrosion products in reactor cooling water is discussed. Data were obtained by chemical analyses of the water rather than from physical measurement of the test specimen. (auth)

4719 REFLUXING CAPSULE EXPERIMENTS WITH REFRACTORY METALS AND BOILING ALKALI METALS. DiStefano, J. R.; DeVan, J. H. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 29-44(Jan 1970).

Refluxing capsule tests were conducted to evaluate the corrosion properties of alloys Nb, Nb–1% Zr, Nb–10% W–1% Zr, Ta–8% W–2% Hf, Mo–0.5% Ti–0.1% Zr, Nb–10% W–10% Hf–0.5% Y, and W–26% Re in boiling potassium at 1100 to 1400°C. Nb–1% Zr was also evaluated in refluxing sodium, rubidium, and cesium at 1200°C. Alloys of niobium or tantalum that contained strong oxide formers, such as zirconium or hafnium, showed negligible corrosion effects up to 1300°C for times as long as 5000 h. Nb–1% Zr exposed to the other alkali metals was similar. Weight changes in insert specimens from condenser sections were small and in most tests were traced to the migration of oxygen in the system. Unalloyed niobium, on the other hand, was very heavily attacked under similar conditions. Mass transfer of tungsten was observed in a W–26% Re capsule. Capsule geometry can be an important variable in comparing the results between various corrosion investigations. (auth)

4720 RAPID TEST FOR STRESS-CORROSION CRACKING. Orman, S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Corros. Sci.; 9: 849-51(Nov 1969).

A simple rapid test was used to examine the susceptibility to stress–corrosion cracking of a variety of alloys. The results are in agreement with those from longer term tests. The advantages claimed for this test are speed of assessment and the use of standard laboratory apparatus. Alloys examined included U–10 wt % Mo, U–7.5 wt % Mo, U–7 wt % Nb–2.5 wt % Zr, U–6 wt % Nb, mild steel and stainless steel. α-recrystallized U was also tested. (auth) (UK)

4721 EARLY STAGES OF THE OXIDATION OF ZIRCONIUM METAL. Srivastava, Lakshmi Prakash. Seattle; Univ. of Washington (1968). 344p.

Thesis.

The oxidation of zirconium has been carried out by exposing foil specimens in flowing oxygen, oxygen-argon, air, and oxygen-nitrogen atmospheres at temperatures ranging from 440 to 850°C. The maximum exposure time was three minutes, and the weight changes were determined after periodic removal of the specimens from the gas stream. The oxidation of both electropolished and abraded specimens follows a combination of a linear rate law corresponding to a surface reaction and a parabolic rate law corresponding to a diffusion mechanism. Zirconium oxide films formed during the oxidation of zirconium are non-stoichiometric. The oxide is an n-type semiconductor below approximately 685°C, and it is a p-type above this temperature; the defect concentration in the oxide is oxygen pressure dependent. The diffusion of oxygen occurs via oxygen vacancies in the n-type region and via zirconium vacancies in the p-type region. Relevant thermodynamic parameters such as the activation energy ($Q_p \cong \Delta E \cong \Delta H$), the entropy ($\Delta S$), and the free energy ($\Delta F$) for parabolic oxidation have been determined; the diffusion coefficients for the diffusing species have also been determined. The effects of dislocations in the metal and the metal grain size are discussed. The linear rate constant for the surface reaction has positive and negative values. The negative values are attributed to a passivation process. A tentative model for an internal desorption has been proposed. Electropolished and abraded surfaces of zirconium have been examined by the use of optical microscopy, and transmission electron microscopy by making carbon replicas. The oxide films formed on electropolished, abraded, and rolled and annealed surfaces of zirconium have been examined by the use of transmission electron microscopy. Some of the results have been correlated to the oxidation kinetics. Transformations in the microstructures occurring during the heating of oxide films in the electron beam of the microscopy have been reported. (Diss. Abstr.)

4722 OXIDATION CHARACTERISTICS OF TUNGSTEN–CHROMIUM–PALLADIUM ALLOYS. Evans, D. S. (General Electric Co. Ltd., Wembley, Eng.). pp 42-56 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Tungsten-chromium-palladium alloys containing typically 10% Cr and 1% Pd by weight show good oxidation resistance when heated in air. Typical lives of specimens 0.5 cm -diameter, 2.5 cm long are 500 hr at 1200°C, 100 hr at 1400°C and 1 hr at 1800°C. The alloys show low rates of weight gain during their oxidation life, in the range 0.01 to 1.5 mg cm^{-2} hr^{-1}, but eventually fail catastrophically. Their oxidation resistance is substantially unaffected by severe thermal cycling, and the alloys show good self-healing characteristics when heated to high temperatures. The protection mechanism appears to be due to the presence of an oxidation resistant palladium-rich phase which can form, even under conditions of rapid oxidation, a continuous protective layer over the highly oxidizable tungsten-rich matrix. (auth)

4723 STUDIES OF HIGH TEMPERATURE OXIDATION OF HAFNIUM–NIOBIUM ALLOYS. Kofstad, P.; Kvernes, I. (Central Inst. for Industrial Research, Oslo). pp 291-316 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Oxidation of binary Hf-Nb alloys with 10 to 50 wt% Nb has been studied in the temperature range 800 to 1300°C. Most of the studies were carried out at 10 torr O_2, but for one of the binary alloys (Hf-34 wt % Nb) the effect of oxygen pressure (1 atm–10^{-3} torr O_2) was also investigated. The experimental methods included thermogravimetric measurements of oxidation rates and studies on reacted specimens by means of x-ray diffraction, metallographic techniques, and electron microprobe analysis. The major reaction products were HfO_2, Nb_2O_5, and $Nb_2O_5 \cdot 6HfO_2$, and the relative amounts of these were a function of temperature, oxygen pressure, and elapsed time of reaction. At 10 torr O_2 and higher oxygen pressures oxidation of the binary alloys exhibits an irregular temperature dependence and goes through a maximum 950 to 1000°C. Above 1100°C the oxidation rate again increases with temperature. This maximum in oxidation rate is interpreted as a result of an interplay between relative rates of formation of HfO_2 and Nb_2O_5 and their subsequent reaction to form $Nb_2O_5 \cdot 6HfO_2$. At and below 0.1 torr O_2 the maximum in oxidation rate is absent. At certain temperatures the pretreatment of the specimens may influence the oxidation rate. The binary Hf-Nb alloys exhibit comparatively rapid oxidation rates, and at the maximum in oxidation at 900 to 1000°C the rates are as fast as for unalloyed niobium. (auth)

4724 INVESTIGATIONS ON TITANIUM ALLOYS OF BRITTLE CRACK FORMATION BY OXIDATION AT HIGH TEMPERATURES. Zwicker, U.; Kalsch, E. (Univ., Erlangen, Ger.). pp 386-92 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

High temperature titanium alloys, which contain in most cases aluminum as alloying element, show a tendency at high temperature to brittle crack, in which the maximum attainable expansion of the samples decrease with increasing test time. Studies on the alloys TiAl6V4 amd TiAl9V3 at and over temperatures of 450°C have shown that at research times of and over 1000 hr a brittle crack formation can occur. At the grain boundaries and at the surface an enrichment in oxygen and aluminum is found by which a superstructure of the α-mixed crystals are formed. This process accelerates the crack formation since the deformation mechanism was strongly altered by the formation of the ordered state. In samples which show a polygonal grain, the brittle fracture always occurs at intercrystalline locations as a result of the oxygen and aluminum enrichment at the grain boundaries. In alloys which are cold worked before the stress at high temperature, the grain boundaries are disturbed and the intercrystalline fracture can no longer occur. After sufficiently long duration study of thick samples no decrease in the expansion and contraction was observed. (tr-auth)

4725 REACTIONS OF POSSIBLE CANNING MATERIALS IN FAST BREEDERS WITH UN AND UO_2. Goetzmann, O.; Thuemmler, F. (Kernforschungszentrums, Karlsruhe Ger. Univ., Karlsruhe, Ger.). pp 439-66 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The compatibility of vanadium, vanadium–titanium alloys, iron-base alloys, and nickel-base alloys with UN and UO_2 were investigated. The annealing temperature was between 750 and 1500°C for the individual systems. The annealing time extended up to 144 hr. The studies were carried out with open and capsuled samples. As a result of the studies temperature limits for the compatibility of canning materials with the nuclear fuels were obtained. The interactions occurring were described and, so far as possible, the kinetic data for the reactions were calculated. Uranium diffusion in the can occurs to the greatest degree in vanadium–titanium alloys at 800 to 900°C. With high titanium content the diffusion increases. The nitrogen diffusion leads to sharp TiN precipitations in the can which probably facilitates the uranium diffusion. Oxidation phenomena in UN lead to the conclusion that a sharper oxygen diffusion occurs in pure vanadium than in vanadium–titanium alloys. With increasing titanium content the oxidation of UN decreases. The addition of titanium in the vanadium alloys reduces strongly the compatibility with UN; with UO_2 the deterioration is first caused at higher titanium contents. In the iron-base and nickel-base alloys in combination with UN the reaction to UNi_5 is considered as the criterion for compatibility. The uranium diffusion in the lattice of the canning material is very low whereas the diffusion of UNi_5 along the grain boundaries is considerable. Titanium content affects the compatibility behavior with UN unfavorably. With increasing nickel content the compatibility of UN with the iron-base and nickel-base alloys was worsened. In contrast with the open system, in the capsuled samples the UNi_5 formation was sharply decreased or suppressed whereas the titanium reaction was predominant. UO_2 shows with the exception of UVi20 alloy, the best compatibility with UN. (tr-auth)

4726 ZrO_2-COATINGS ON NIMONIC ALLOYS. Nijpjes, J. M. (Metaalinstituut TNO, Delft, Netherlands). pp 481-99 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

After pretreatment with Al_2O_3 particles to roughen the surface, sprayed ZrO_2 layers were used to protect the nickel super alloy substrate against temperatures above 1000°C. The coating parameters and the interlayer were varied until a relatively stable substrate coating combination was made. The specimens were tested by thermal cycling. Some specimens could resist a temperature gradient of about 1000°C over a thickness of 1 mm at which the substrate temperature was up to 1000°C and the coating temperature up to 2000°C. The influence of the coating techniques and the coating on the high temperature creep and fatigue properties are also studied. (auth)

4727 COATING PROBLEMS. Bueckle, H. (ONERA, Paris). pp 703-25 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The formation mechanism of the protective layers for Va and VIa metals depends on the multiphase diffusion which is to be considered in modern powder compression methods in connection with halogenide reactions. The latter can be limited to the donor side without disturbing the diffusion or it can occur with diffusion in interaction and lead to very complex methods. Whereas the pure diffusion method is more manageable on the basis of its regularity, many complex compounds are characterized by other advantages. Two empirical methods of this type are described. With AlF_3-containing Si donors, $MoSi_2$ layers of 30 to 40 μm were obtained on Mo after a one-hour siliconizing at 700°C, whereas the usual methods require 1100 to 1200°C for the attainment of such thicknesses. The avoidance of a de-strain hardening of the nuclear material by crystal recovery is the principal advantage. Microhardness studies results show a lower brittleness in spite of higher hardness that the usual $MoSi_2$ layers (1800 instead of 1300 kg/mm^2). The reproducibility was made difficult by various factors only empirically controllable. Their effects were discussed. The results indicate a pure diffusion mechanism and can detect no direct relation with the structure transformation C 11b ⟷ C 40, but rather corresponds to a selective exchange reaction. With increasing temperature the abnormal layer growth passes through a minimum at 850 to 900°C continuously in the scattering range of the conventional results. By siliconization of the carburized molybdenum samples well-adhering protective layers are formed, which are harder than the Mo_2C layers and almost as oxidation resistant as the $MoSi_2$ layers. The results of previous studies on formation rates are reported. (tr-auth)

4728 LOW-TEMPERATURE SILICATION OF MOLYBDENUM. Fitzer, E.; Langseth, L.; Schlichting, J. pp 726-30 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The coating of Mo with $MoSi_2$ layers using $AlF_3 \cdot 3H_2O$ as the activation medium was studied as a function of the temperature and time. At temperatures above 850°C, the layer growth occurs by displacement in the solid state, in which the diffusion of the silicon to the molybdenum can be assumed as the rate determining step. With different layer formation mechanisms various textures result. At temperatures above 850°C a recrystallized $MoSi_2$ texture occurs, whereas below 800°C there is a clear stalk crystal texture. The transformation of the hexagonal into the tetragonal phase after recrystallization is irreversible. The high rate of the $MoSi_2$ layer growth of the low temperature modification is another rate determining step. (J.S.R.)

4729 APPLICATION OF REFRACTORY MATERIALS AS DIFFUSION BARRIERS. Chao, P. J. (RCA Electronic Components, Harrison, N. J.). pp 731-9 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Development of barriers in the form of coatings on Hastelloy B to prevent interdiffusion of Au and Hastelloy B is described. Preliminary evaluation of Cr–Si bonded coatings on the alloy reveals that such coatings should be further investigated. (J.R.D.)

4730 SILICON DIFFUSION IN PROTECTIVE-LAYER-FORMING SILICIDE PHASES OF HIGH-MELTING METALS. Fitzer, E.; Matthias, K. (Univ., Karlsruhe, Ger.). pp 740-66 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

A quantitative comparison is made of the concurrent consumption of a $MoSi_2$ coating on molybdenum by selective Si oxidation and by Si out-diffusion in the Mo core. Optimum silication conditions were determined for temperatures over 1000°C for the preparation of $MoSi_2$ layers thicker than 50 μ. The kinetics of the Mo_5Si_3 and Mo_3Si phase formation—necessary for the comparison of the concurrent $MoSi_2$ layer consumption—was determined by measurement of the homogeneity ranges ($MoSi_2 \sim 0.5$ wt %, $Mo_5Si_3 \sim 0.4$ wt %, and $Mo_3Si < 0.3$ wt %) by labeling studies and by layer thickness measurements in the temperature range between 1200 and 1700°C. The oxidation kinetics on $MoSi_2$ coatings on Mo in the temperature range between 1450 and 1600°C in air at 1 atm was followed gravimetrically. It exceeds that measured (literature values) on $MoSi_2$ solids. With these values the concurrent $MoSi_2$ layer consumption can be calculated. The results were experimentally verified in the temperature range between 1400 and 1600°C. A $MoSi_2$ layer on Mo was consumed in an oxidation treatment by Si out-diffusion in the Mo core by one or two powers of ten faster than by oxidation. By absorption of the $MoSi_2$ phase a layer system on a Mo_5Si_3 basis occurs, which under the prepared SiO_2 layer guarantees an oxidation protection. The Mo_5Si_3 layer of this system was used up about equally by oxidation and Si out-diffusion. For retardation of the fast $MoSi_2$ consumption diffusion limiting intermediate layers of tungsten and tantalum ($MoSi_2$/W/Mo, $MoSi_2$/Ta/Mo) were suitable. The diffusion rate in these layer systems can be determined by microanalytical determinations and layer thickness measurements in the temperature range between 1600 and 1750°C. (tr-auth)

4731 CORROSION RESISTANT COATINGS FOR REFRACTORY METALS AND SUPERALLOYS. Gadd, J. D. (TRW Equipment Labs. Inc., Cleveland). pp 803-37 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

A review is presented of the development and evaluation of coatings for the protection of niobium, nickel, and cobalt base alloys in aircraft gas turbine applications. A vacuum pack method is described for the formation of Cr-Ti-Si coatings on Nb alloys. Analogous processing sequences are described for the formation of modified aluminide coatings on nickel and cobalt base superalloys. Evaluation of the coated alloys involved exposure in air, and in a simulated aircraft gas turbine environment. The latter test employed a high velocity hot gas stream produced by the combustion of aviation turbine fuel. Synthetic sea salt was aspirated into the exhaust gases to increase the severity of the corrosive environment. Visual examination, weight change analysis, metallographic examination and electron microprobe analysis were utilized to evaluate coating protection and degradation. Diffusional behavior and phase formation during coating application and subsequent corrosion testing are discussed for the various coating-base metal systems. Models are presented which describe the general coating formation and degradation process characteristic of the various composites. (auth)

4732 PROTECTION OF NIOBIUM ALLOYS AGAINST OXIDATION. Stecher, P.; Lux, B.; Funk, R. (Institut Battelle, Geneva). pp 885-921 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In French).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Coatings with self-repair properties were used for protection of niobium and its alloys against oxidation. In these coatings, a silicide layer was associated with a thin—aluminum alloy with low fusion point. Results are reported with respect to the behavior of two systems as protective layers during oxidation tests in air under static and cyclic conditions. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 4801, 4813, and 4829.

4733 (CEA-R-3875) REDUCTION OF AMERICIUM OXIDE BY BERYLLIUM FOR NEUTRON-SOURCE PRODUCTION. Brachet, Guy; Vasseur, Claude (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Oct 1969. 15p. (In French). Dep. CFSTI (U. S. Sales Only).

A method was developed for making americium—beryllium neutron sources by the reduction of americium oxide with beryllium. This method has a certain number of advantages over those using a target-emitter mixture without formation of the definite compound $AmBe_{13}$. An emission of 3.75×10^6 n/sec is obtained with 1 gram of alloy having a volume of about 0.3 cm^3. The yield of such a source is 2×10^6 n/sec/Ci of emitter. (auth)

4734 (ORNL-4440, pp 59-71) ZIRCONIUM METALLURGY. Weir, J. R. Jr.; Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.).

Studies of texture development in Zircaloy tubing have shown that the texture produced during each fabrication step depends on the ratio of wall reduction to diameter reduction in that step and on the texture that existed before the fabrication. All procedures for forming tubing result in essentially identical textures when they are carried out with similar reductions in area, wall thickness, and diameter. When reduction in wall thickness exceeds the reduction in diameter during a fabrication step, a Zr sheet texture is formed; if the reverse is true, the basal poles align parallel to the circumference of the tubing. The concepts of texture development that have been demonstrated were used to explain texture gradients observed in Zircaloy tubing. A method was developed of controlling the texture in Zircaloy tubing based on the interrelationships among variables of tubing fabrication and application of sound concepts of texture development. Plots of fabrication variables are used to predict the textures that will be formed during any given series of fabrication steps and are the basis of fabrication sequence designs used to promote any of the possible textures desired in the final product. Relationships between the uniaxial yield strength, the intensity of the basal poles of the texture, and the equivalence of certain stress states allow production of biaxial yield surfaces for Zircaloy tubing of any texture. That differences in biaxial yield stresses between different lots of tubing exceeds 50% has been verified experimentally. (auth)

4735 (ORNL-4440, pp 117-42) MECHANICAL PROPERTIES RESEARCH AND LMFBR CLADDING AND STRUCTURAL MATERIALS DEVELOPMENT. Weir, J. R. Jr.; McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.).

Tests of type 316 stainless steel after 20% cold work showed that cold working increased the rupture life and decreased the minimum creep rate but hastened the onset of third-stage creep. By contrast, cold working modified type 316 stainless steel increased the duration of second-stage creep. Measurements of the variation with strain rate of the flow stress of modified type 316 stainless steel suggest that carbides precipitate during testing at 500°C. Incoloy 800 samples were irradiated at 450, 550, 650, and 750°C. Creep tests at 650°C showed generally that with increasing irradiation temperature the rupture life and the strain to fracture decreased and the minimum creep rate increased. The densities of specimens of type 304 stainless steel from an Experimental Breeder Reactor-II (EBR-II) safety-rod thimble were measured. The greatest decrease in density, 3.35%, was observed in a sample from 2 in. above the midplane of the reactor that had been irradiated to 6.5×10^{22} $neutrons/cm^2$ (>0.1 MeV) at an estimated temperature of 410°C. Voids in samples of V removed from the EBR-II were found whereas V—20% Ti irradiated under the same conditions did not contain voids. Moderate changes were noted in the properties of samples of Hastelloy N modified with Ti that were aged at 650 and 760°C and tested in tension at 650°C. Analysis of the carbides extracted from several samples showed that Ti substitutes for Cr in the carbides as the Ti level increases. (auth)

4736 (ORNL-4440, pp 145-54) TUNGSTEN METALLURGY. Schaffhauser, A. C.; Patriarca, P. (Oak Ridge National Lab., Tenn.).

The use of tensile tests of ring specimens was investigated for determining the properties of extruded W tubing as an aid in optimizing the extrusion conditions. Preliminary tests on specimens cut from tube shells that were duplex extruded between 1750 and 1250°C showed that the ductility at 300°C is greater for the material extruded at the lower temperature. Five chemical vapor deposits of W sheet with low F content were prepared. Each deposit provided 55 $in.^2$ of 0.060-in.-thick sheet for tests of mechanical properties. In efforts to produce W—5% Re sheet of similar quality, higher gas flow, periodic reversal of gas flow, and periodic interruption of gas flow were studied. A combination of the latter two techniques appeared most promising. Fully dense deposits of V have been produced by H_2 reduction of both VCl_4 and VF_5 at 1200°C. Additional long-time creep-rupture data for arc-melted W—5% Re were obtained at 1400, 1650, and 2200°C. The Larson-Miller constant calculated from these results was used to obtain an estimate of the creep-rupture curves at 1800 and 2000°C. (auth)

4737 (ORNL-4440, pp 160-75) JOINING RESEARCH ON NUCLEAR MATERIALS. Adamson, G. M. Jr.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

Studies of hot ductility showed that S decreased the hot ductility of alloys rich in Ni and drastically impaired their ability to recover after a thermal exposure to a peak temperature of 1345°C. Manganese did not improve their hot ductility and, indeed, seemed to have a somewhat detrimental effect. Phosphorus was not detrimental. Scanning and transmission electron microscopy results indicate that Ti negates the deleterious effect of S in alloys with intermediate Ni content through the formation of compounds. X-ray analysis of extracted precipitates has identified them as titanium disulfide and titanium nitride. Moreover, the beneficial effect of Ti on the ductility minima at 760 to 870°C stems from its ability to enhance recrystallization. A metallographic study is under way on stainless steel in support of the Fast Flux Test Facility. The distribution and amount of ferrite were found to vary greatly as a function of the welding process. Moreover, significant differences were observed within a given cross section. Nondestructive examination of the weldments was completed in which deliberate discontinuities were produced. Good correlation was shown between through-transmission ultrasonic techniques and radiography. For the specimens under study, radiography proved more sensitive to three-dimensional flaws. (auth)

4738 (ORNL-4440, pp 176-91) DEVELOPMENT OF LMFBR TUBING FABRICATION. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Schedules for mandrel drawing and annealing of type 316 stainless steel were varied to determine the extent to which differences in the technique of fabrication affect the structures and properties of the final product. Interpass annealing temperatures were varied from 925 to 1050°C at a reduction of area per pass of about 20 and 40% for the first and second schedules, respectively. All tubing was tested nondestructively, and 70% of the tubing appears to meet the Fast Flux Test Facility specification limits for flaws and eccentricity. Tubing of type 304L stainless steel alloy modified with 0.2% Ti was fabricated by both drawing and planetary swaging for the final reductions. Textures that are characteristic of either drawing or planetary swaging develop after very small reductions, maximum intensities are reached very early in the reduction schedule, and the intensity peaks sharpen with increasing amounts of cold work. Biaxial stress-rupture properties of Ti-modified type 304L stainless steel are the basis of a conclusion that ultrasonically detectable defects reduce rupture life and ductility, particularly for cold-worked tubes in which internal bore defects are difficult to find using nondestructive testing techniques. (auth)

4739 (RFP-1188) BOMB REDUCTION OF AMERICIUM TETRAFLUORIDE TO METAL. Conner, William V. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 17 Nov 1968. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Americium metal was prepared on a gram scale using a thermite bomb method. The metal was prepared by converting AmO_2 to AmF_4 with fluorine and reducing the AmF_4 with calcium metal. Reduction yields of 34 to 64% were obtained. (auth)

4740 (RISO-193) MANUFACTURE AND EXAMINATION OF DISPERSION-STRENGTHENED ALUMINIUM PRODUCTS: EXPERIMENTAL PROCEDURES. Hansen, Niels (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1969. 59p. Dep. CFSTI (U. S. Sales Only).

The manufacture and examination of dispersion-strengthened aluminum products is based on a number of standard techniques supplemented by some new procedures. A review of these methods is given together with some experimental results obtained during the development work. The methods cover powder analysis, manufacturing processes, and examination of solid material. The powders examined were atomized aluminum powders with particle sizes of 3 to 100 microns and aluminum-oxide powders with particle sizes of 0.1 to 1 micron. The powders were mainly characterized by density, particle size, and surface area measurements and by x-ray structural analysis. The manufacturing processes were oxidation of aluminum powder and powder blending followed by consolidation steps such as cold compaction, hot pressing, and extrusion. The consolidated products were examined together with SAP and aluminum by chemical analysis, optical and electron microscopy, and mechanical testing. (auth) (Denmark)

4741 IMPROVEMENTS IN OR RELATING TO MEANS FOR PURIFYING SODIUM. Graff, Willy Henri; Champeix, Jean Marcel (to Commissariat a l'Energie Atomique). British Patent 1,167,382. Oct. 15, 1969. Priority date Dec. 30, 1965, France.

Sodium is purified by heating to 110 to 120°C, adding Na_2O_2 to the molten Na with agitation, raising the temperature of the agitated mixture to 200 to 300°C, lowering the temperature to 110°C, and filtering. The temperature of the agitated mixture is maintained at 200 to 300°C for a period of time sufficient to permit the peroxide to react completely with the Ca present as an impurity. (B.L.M.)

4742 ELECTROSLAG WELDING OF LOW BOND STEELS FOR NUCLEAR POWER PLANTS. Cappelli, P. G. (FIAT, Turin); Frigerio, G.; Caputo, G.; Rovetta, E. Riv. Ital. Saldatura; No. 6, 275-89(1968). (In Italian).

Results of a series of tests performed to set up the electroslag welding process are discussed. Vertical and circumferential welding are considered and the advantages of employing this welding process in fabrication of nuclear pressure vessels are discussed. The tests were performed on 100 mm thick ASTM A302B steel. (auth)

4743 NEW DEVELOPMENTS IN HIGH DENSITY, HIGH COMPRESSIBILITY FERROUS POWDERS. Huseby, Robert A. ASTME Paper No. EM69-555. Dearborn, Mich., American Society of Tool and Manufacturing Engineers, 1969. 7p.

Data are presented on the powders and on the hardness, hardenability, dimensional stability and tensile properties of sintered parts made of resulfurized grades of powdered steel (comparable to free-machining AISI B-1100) and Cr-Ni-Mo (modified AISI 8600 8600) and Ni-Mo (modified AISI 4600) powders. The potential is indicated for substitution of high-density ferrous powder parts for malleable iron and cast and wrought steel parts. Developments in the technology of sintered metal preforms for hot forging are discussed. (Metals Abstr.)

4744 NEW OBSERVATIONS ON THE ELECTROCHEMICAL DIFFERENTIAL EFFECTS [FOR THE DECORATION OF METALS]. Piontelli, R.; Pedeferri, P. Electrochim. Metal., 3: 379-85(Oct.-Dec. 1968).

A technique has been developed for the production of decorative striped effects on metals by pretreatment in an insulating liquid followed by immersion in an electrolyte, while an alternating voltage is applied between the object and a counter electrode. The process was developed for Ti but has now been found to be suitable for Ti alloys, W, Nb, Ta, and Zr. The mechanism is discussed and examples illustrated. (Metals Abstr.)

4745 APPLICATIONS OF SPECIAL METALS (TITANIUM, ZIRCONIUM, TANTALUM, NIOBIUM, AND BERYLLIUM). Perez, M.; Molinier, R.; Syre, R. Tech. Mod., 61: 117-20(Apr. 1969). (In French).

The applications of the newer metals in industry are reviewed. Ti and its alloys with Al and V are becoming increasingly used in aero engines. Nb and Ta are used in aeronautical and space applications, although the high densities of these two metals inhibit their use to some extent. Be has heat-sink capacities, low density, and very low attenuation to x-rays. Zr has applications in reactors. (Metals Abstr.)

4746 HOMOGENEITY CHARACTERIZATION OF NBS SPECTROMETRIC STANDARDS. IV. PREPARATION AND MICROPROBE CHARACTERIZATION OF W-20 PERCENT Mo ALLOY FABRICATED BY POWDER METALLURGICAL METHODS. Yakowitz, H.; Michaelis, R. E.; Vieth, D. L. (National Bureau of Standards, Washington, D. C.). Advan. X-Ray Anal., 12: 418-38(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

A significant problem of the National Bureau of Standards Standard Reference Materials program is the provision of standards suitable in homogeneity for use with microanalytical techniques such as the spark source mass spectrograph and the electron probe microanalyzer. An interim approach to the problem has been the extended homogeneity characterization of selected existing standards. The preparation and evaluation of the first NBS standard tested specifically from the beginning for application to electron probe microanalyzers is described. The standard designated SRM 480 is a tungsten-20 wt % molybdenum alloy prepared by a powder metallurgy process. Based on the results of about 1500 determinations for both tungsten and molybdenum by electron probe microanalysis, the material was found to be of high homogeneity at about the micrometer level of spatial resolution. The coefficient of variation for molybdenum was 2.5% and that for tungsten 1.5%. Correction of relative intensity ratios to obtain concentrations is discussed in terms of input parameter uncertainties such as mass absorption coefficients, and electron backscatter factors. The result of studies for atomic number correction and effects on operating voltage on the microprobe absorption correction, will be given. It is concluded that SRM 480 should be a valuable addition to any microprobe laboratory doing quantitative analyses. (auth)

4747 PRODUCTION OF REFRACTORY ALLOYS AS POWDERS, FIBERS, AND AS FRITTED BILLETS BY THERMOCHEMICAL METHODS. Galmiche, P.; Hivert, A.; Marty, M. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux, France). pp 410-23 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In French).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The ONERA procedures, in which properties of the halogen atmospheres are used to promote transport, the deposition, and the diffusion of strongly electro-positive metals on metals or alloys less electropositive, were applied with success both on the laboratory and the industrial scale for the preparation of different primary materials or semiproducts of powder metallurgy. By altering the time and temperature parameters it is possible to obtain either coatings of particles or fibers or a diffusion to the core (examples: fine or ultrafine powders of Ni-Cr 80/20, fine or ultrafine powders of the refractory steel Fe-Ni-Cr 25/20, in which the powders are surface covered by chromium diffusion.) Proper management of the operations leads either to dynamically free powders or to porous billets, the chemical composition of the materials prepared can be predetermined with precision and the materials obtained were practically devoid of impurities. Particular modifications of these procedures made it possible to resolve the problem of the incorporation of chromium in $Ni-ThO_2$ type dispersed phase alloys. In this case, chemical analyses, examinations by electron microscope, and mechanical tests have shown that the treatment, defined so as to be applicable and reproducible at the currently practical stage gave the following results: (a) homogeneous and complete diffusion of the chromium; (b) non pollution of the metallic matter by parasite oxides (oxygen content less than 500 ppM); and (c) strict maintenance of the initial characteristics of the ThO_2 dispersed phase. $Ni-Cr-ThO_2$ alloys prepared by extrusion and welding of those semiproducts (chromium content equal to 20%) having characteristics of mechanical behavior during hot traction about equivalent to that obtained on $Ni-ThO_2$ alloys with a much higher resistance to oxidation and corrosion. Dispersed phase alloys having more complex metallic matrices, with improved mechanical characteristics, can be obtained under the same conditions. (tr-auth)

4748 MECHANISM OF THE DEPOSITION OF METALS FROM THE GASEOUS PHASE. REDUCTION OF VANADIUM TETRACHLORIDE BY HYDROGEN. Val, C.; Accary, A. (CEN, Saclay, France). pp 424-38 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In French).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Mechanisms for the deposition of vanadium by reduction of its tetrachloride with hydrogen are reviewed. It was impossible to determine absolutely which is most effective; however all mechanisms having a thermodynamic equilibrium between all the chemical species present in the reaction zone can be excluded. It appears that the deposition rate was controlled by the kinetics of the reactions in adsorbed phase at the surface of the vanadium. However the sequence of the two reactions in the gaseous phase $VCl_4 + H_2 \rightleftharpoons VCl_2 + 2\,HCl$ and $VCl_2 + H_2 \rightleftharpoons V + 2\,HCl$ followed by the condensation of the vanadium on the substrate according to a mechanism of the Knudsen type can not be absolutely rejected. The conclusions in the case of the mechanism of vanadium deposition are different from those of W. Steinmaier in the case of silicon which affirms that the deposition rate was limited by two equilibrium reactions in the gaseous phase; on the contrary they approach those proposed by A. C. Loonam in the study of the deposition mechanisms of tin by the Van Arkel hot wire procedure. (tr-auth)

4749 ELECTRON-BEAM WORKING OF HEAT-RESISTING MATERIALS. Dorn, L. pp 988-97 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The properties of electron beams as heat sources are described. The advantages of welding with electron beams are outlined. Drilling and perforation techniques with the electron beam are discussed. (J.S.R.)

4750 REFRACTORY METAL FIBER REINFORCED COMPOSITES. Berghezan, A. (Union Carbide ERA, Brussels). pp 922-49 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

In methods to combine in a single material the best properties of the existing and easily available materials to get a composite structure possessing both adequate strength and oxidation resistance at 1800°F and above were investigated. Strong refractory metals in a fiber form have been incorporated (by extrusion) in an oxidation-resistant matrix. In this way, the refractory metal fibers are protected against oxidation by the oxidation-resistant matrix, while they reinforce the weak matrix, and the resulting material becomes useful in the temperature range where none of the components can be used singly. The components are chosen so as to be compatible with each other in order to optimize the properties of the resulting composites. After incorporation of different volume fractions of fibers and different arrangements in the chosen matrix a preferred concentric ring arrangement has been selected, on which the degree of reinforcement has been measured at 1800 and 2000°F. It has been found, that the degree of reinforcement increases with temperature and depends on the volume fraction of fibers incorporated i.e., follows the law of mixtures. The refractory metal fibers adequately incorporated in an oxidation-resistant matrix seem to provide a new class of materials useful in the most critical high-temperature range at 1800 to 2000°F. (auth)

4751 PRODUCTION OF REFRACTORY MATERIALS IN THE FORM OF FIBERS. Dubee, A.; Grenier, P.; Marchal, M. (Compagnie Francaise Thomson Houston-Hotchkiss Brandt, Bagneux, France). pp 950-70 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In French).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

By incorporation of fibers in a matrix, the sensitivity to rupture of fragile materials, caused by the presence of surface imperfections, is minimized. It, therefore, becomes possible to use the mechanical properties of refractory compounds insofar as the structure components can be prepared in the form of fibers. The recent techniques of development of refractory materials by chemical reactions in the gaseous phase has given birth to two new classes of fibers, the trichites and continuous filaments. Among these materials, alumina trichites attain resistances to rupture of the order of 1000 kg/mm^2 and the continuous filaments of silicon carbide have a resistance to rupture of the order of 250 kg/mm^2. These properties can be preserved at high temperature. The use of such refractory compounds under the form of fibers, in association with various metallic matrices, make it possible to move toward high temperatures the limits of use of these matrices. (tr-auth)

4752 APPLICATIONS OF SOLID-PHASE BONDING TO REFRACTORY METALS. Gripshover, P. J. (Battelle Memorial Inst., Columbus, Ohio). pp 971-87 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The refractory metals possess special fabrication problems because of their high melting points and poor oxidation resistance. Modifications of standard primary and secondary working techniques, welding, and brazing have been found suitable to some but not all of the refractory metal alloys being considered. Experiments have shown that many fabrication problems can be overcome by the application of the gas-pressure-bonding process to refractory metals and their alloys. The gas-pressure-bonding process has been used for both solid-phase joining and powder-metallurgical applications. Techniques are discussed for solid-phase bonding niobium, molybdenum, tantalum, rhenium, tungsten, and their alloys to themselves and to other refractory metals. Bonding parameters, surface preparations, and microstructural interpretation of the resulting bonds are discussed. Examples are presented of practical applications of this joining process to refractory metal structures. An analysis of the relative advantages and limitations of the solid-phase-bonding technique is also presented. (auth)

4753 THE PROPERTIES OF C.V.D. DEPOSITS OF W AND W–Re ALLOYS. Roberts, L. W. (Univ. of California, Livermore). pp 880-4 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Techniques for production of strong W and Re–W deposits in tubular shapes are described. (J.R.D.)

4754 VAPOR DEPOSITION OF REFRACTORY MATERIALS. Shroff, A. M. (Compagnie Generale de Telegraphie san Fil, Corbeville, France). pp 854-79 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Vapor deposited refractory metals formed either by the reduction using hydrogen or decomposition of their halides is a versatile and low cost technic for forming coatings or objects which are not easily available by classical metallurgy. The main application is the fabrication of emitters for thermionic power generators, high temperature heat-pipe for isothermal heat transmission, nuclear fuel coating, x-ray tubes anticathodes, and crucibles. The equipment used for the experimental approach is described and results concerning the deposition of tungsten, niobium, and rhenium are presented. Applications are also discussed. (auth)

4755 A SINTERED NICKEL-BASE SUPERALLOY SUITABLE FOR GAS TURBINE BLADES. Strachan, J. F.; Soler-Gomez, A. J. R. (General Electric Co. Ltd., Wembley, Eng.). pp 539-67 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The sintered nickel-base alloy N15 has a stress-rupture life equivalent to that of the best wrought nickel-base alloy, Nimonic 115. Shaped turbine blade blanks, made in sintered N15 by an isostatic pressing and sintering process, were machined and tested. There was no evidence of corrosion, cracking or necking of the blades after the test. The stress-rupture, tensile and fatigue strength, impact strength, thermal shock and thermal expansion properties of sintered N15 are given and the fabrication of sintered turbine blade blanks described. The microstructure of the alloy, determined by x-ray, electron-microscopic and x-ray probe microanalysis techniques is presented. The relations between the microstructure and the mechanical properties are discussed. The importance of the grain boundary phases is stressed and some current problems in their detailed identification discussed. (auth)

4756 COMPARISON OF DIFFERENT METHODS OF PURIFICATION OF HAFNIUM. Armand, M.; Givord, J. P.; Herold, R. (Ugine Kuhlmann, Venthon, France). pp 237-55 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In French).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Hafnium sponge obtained by reduction of the tetrachloride by Mg, contains several elements such as oxygen and nitrogen, which although in low quantities, act very unfavorably on its ductility characteristics and make difficult its direct utilization after a simple fusion in arc furnace with consumable electrode. Three methods of purification were studied: the Van Arkel method which consists in forming gaseous hafnium iodide by reaction of iodine vapor on the metal to be purified, followed by dissociation of this iodide on a hot filament; soluble anode electrolysis in fused salt medium; and slow fusion in electron beam furnace. The three methods give interesting but variable results according to the impurities. From this fact the methods can be considered to a certain extent as complementary. However fusion by electron bombardment, although it does not eliminate the nitrogen, has the advantage of a great simplicity and a higher productivity. Moreover, it yields the refined metal in the form of directly usable ingots. (tr-auth)

4757 DEVELOPMENT OF HEAT-RESISTING AND CORROSION-RESISTANT VANADIUM-BASE ALLOYS FOR NUCLEAR TECHNOLOGY. Boehm, H.; Borgstedt, H.-U.; Ruehle, M.; Wincierz, P. (Metallgesellschaft AG., Frankfurt am Main). pp 256-75 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Research concerned with vanadium alloy mixed crystals hardened by the elements Ti, Cr, Nb, and Mo, is reported in which the quantity is limited with reference to the maintenance of the neutron economy. The ductility of most of the mixed crystal hardened vanadium alloys is improved by Ti and Zr additions. In contrast with the deformation of cast rods or cast buttons the extruding press offers greater concentration ranges on processed alloys. Jackets with the dimensions 7 mm × 0.4 mm were prepared from V–Ti–Nb alloys. The heat stability of binary V–Ti alloys increases in the temperature range from 600 to 800°C sharply with the Ti content. Ternary Nb additions bring a supplementary stability increase and extends the effect of the Ti extensively. In contrast the highest time stability was obtained at Ti content ≤ 3%. With increasing Ti content the time stability decreases. The effect of the Nb content is lower with increasing tool life. Neutron irradiation at 50 to 100°C does not lead in the temperature range from 600 to 750°C to a radiation embrittlement. Corrosion studies in flowing sodium at 500 to 650°C show that alloys of the systems V–Ti and V–Ti–Nb have no satisfactory stability. Additional research on alloys with additions of Al, Zr, Cr, and Mo show that the corrosion behavior depends on the oxygen and calcium content of the sodium and on the alloy constituents. Cr was shown as the most favorable alloying element according to the present corrosion studies. The heat conductivity of the V–Ti–Nb alloys increases with the temperature and is at least equal or higher than that of the high heat stable Ni alloys and austenitic steels. (tr-auth)

4758 CARBIDOTHERMIC PRODUCTION OF METALS OF THE IVa, Va, AND VIa GROUPS AND THEIR ALLOYS. Kieffer, R.; Lihl, F.; Effenberger, E. (Technische Hochschule, Vienna). pp 276-90 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

In the preparation of V and Cr by the carbidothermic method, metals result which have considerable purity. The respective mixtures of the atomic ratios C/O could be considered in a large scale production in the initial mixture so that a product with the lowest (C–O) residual amount results. The process of the indirect sintering, coupled with subsequent direct sintering, can be used for the preparation of large quantities. The method described is unsuitable for the carbidothermic production of IVa metals since it is not possible with the conventional means to convert the oxide carbide into a metal. The carbidothermic method for the preparation of alloys can be used for preparation of binary and ternary alloys between Va and VIa metals. In these systems low-melting eutectics occur which work out unfavorably only in the case of vanadium-base alloys. With increasing VIa metal content, use of the method promotes shorter sintering times. In alloys which contain IVa components the metal content of these should not exceed 50 at. % in the case of Ti and 30 at. % in the case of Zr and Hf. For IVa-base alloys (for examples, 70 to 80% Ti) the IVa metal must be added in pure form and corresponding masses to the oxide–carbide mixture in the last reduction step. (tr-auth)

4759 SINTERING OF DOPED TUNGSTEN POWDER. Moon, D. M.; Stickler, R.; Wolfe, A. L. (Westinghouse Research and Development Center, Pittsburgh). pp 67-85 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The effects of trace elements in tungsten such as Si, Al, and K on the powder size and morphology, and the role these impurity elements play in the sintering process were investigated. An electron microscope study of replicas of reduced powders subjected to heat treatments in vacuum and hydrogen atmospheres revealed very fine H_2O_2-insoluble particles which decreased in size and amount with increasing heat-treatment temperature. This decrease was accompanied by a drastic reduction in Si, Al, and O_2 concentration, as determined by chemical analytical techniques. The same tungsten powders were pressed into small ingots and sintered at various temperatures for various times. Density measurements, designed to yield information on pore volume and the closing-up of these pores, showed that initially the density of the sintered ingots increased rapidly to a value characteristic for a specific temperature. Most of the sintering pores remained open and interconnected up to very high sintering temperatures and long sintering times. The chemical analyses of the sintered ingots showed that the impurity content also decreased rapidly to a lower value characteristic of the sintering temperature. The microstructure of the ingots and the distribution of sintering pores were studied by electron microfractography. It was found that at temperatures as low as 2150°C, small necks were formed between individual tungsten particles. These small sintering-neck regions invariably contained numerous small holes, probably gas bubbles, which increased in size with increasing sintering temperatures. The formation and rearrangement of both the sintering pores and the small bubbles are discussed. (auth)

4760 COMPACTING AND SINTERING OF TUNGSTEN POWDER MIXTURES. Barta, J.; Ariel, E. (Israel Ministry of Defence, Tel Aviv). pp 28-41 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The compacting and sintering behavior of ternary mixtures of well-defined tungsten have been investigated. Powders of 45 to 47 microns (coarse), 9.5 microns (medium) and 0.8 microns (average) particle diameter were mixed and compacted, the highest density obtained being 14.4 g/cm^3 for a mixture containing 10% coarse, 70% medium and 20% fine. For comparison, compacts from fine tungsten powder gave a green density of 10.5 g/cm^3. The experimental results do not agree with compositions and maximum densities calculated on the basis of maximum theoretical packing. The mechanical strength of the pellets has also been investigated. The compacts were presintered at 1450°C in dry hydrogen and sintered at between 2200 and 2600°C in vacuum (10^{-5} mm Hg). The densities obtained varied from 80% to 95% of T. D., the results showing that the sintering equations based on theoretical models cannot be applied to practical systems in which the particle size distribution is varied non-uniformly. It has been shown that use of a suitably designed mixture of tungsten powders in compact production has advantages such as high green and sintered densities, control of the density and the porosity of the sintered compacts and improvement in green strength. (auth)

4761 NEW ANGLES IN CUTTING. Sandford, J. E. Iron Age, 203: No. 25, 69-76(June 19, 1969).

Survey of new developments in aerospace machining includes: methods of applying carbide coatings and cutting edges to high-speed steel tools; ceramic tool inserts; the use of micropowder technology to produce ceramic-carbide-metal composites for throwaway inserts; prealloyed powder technology to produce superstrong Co–Cr and Co–Fe base tool alloys; new grades of conventionally produced tool steels; multiple-carbide (W–Ti–Ta) tool materials; carbides with high-melting-point binders (a Nb–Ni binder and a Ni–Mo binder); a tantalum nitride-zirconium diboride cutting material; diamond bits for machining nonmetallic aerospace structures, especially B composites; and numerical control. These new materials are intended for cutting a variety of steels, Ti, tough bronze forgings, Rene 41, Inconel 718 and other Ni-base alloys, superalloys, reactive and refractory metals, and cast iron. Developments in the area of high cutting speeds and feeds, interrupted cuts in hard metals, cutting fluids and the use of positive-rake and negative-rake angles on tools are noted. (Metals Abstr.)

4762 METALS JOINING. Mortland, J. E.; Evans, R. M. (Battelle Memorial Inst., Columbus, Ohio). DMIC Rev.; 4p (6 Jun 1969).

Recent research on the joining of steel, Ti, and Al alloys includes work on: the weld properties of 9Ni–4Co–0.2C and 10Ni–Cr–Mo–Co dual strengthened 180 ksi yield strength steels; gas metal-arc welding of HY-150 steel; weldability of HY-130 steel joined by the shielded metal-arc process; effects of Nb, W and Co additions on the weldability of HY-130 steel; gas Tig welding of 2 in. thick HY-180 steel using filler metal of the same composition; tests of the axial fatigue behavior of 1 in. thick, gas metal-arc, transverse butt welded joints; weld properties of gas tungsten arc welds in Ti–6Al–2Sn–4Zr–2Mo; diffusion welding of Ti–6Al–4V alloy; high-frequency resistance welding of Ti T-shapes; electron beam welding of 321 stainless steel to Kovar for an engine-cutoff sensor tube, and the resistance welding of 2014 Al, 304 stainless steel, and Ti–6Al–4V alloy. New specifications have been issued in aerospace materials by the Society of Automotive Engineers in categories covering welding wire and welded tubing. (Metals Abstr.)

4763 PRODUCTION OF HAFNIUM METAL FROM HAFNIUM OXIDE BY CHLORINE PROCESS. Otsuka, Takeshi; Murata, Akira (Nippon Mining Co., Saitama, Japan). Denki Kagaku, 37: 729-36(Oct. 1969). (In Japanese).

The chlorination of hafnium oxide and reduction of hafnium tetrachloride were studied. The desirable chlorination temperature for hafnium oxide in the presence of carbon was about 900°C. In purifying hafnium tetrachloride by sublimation, it is important to maintain the temperature of the condensation zone between 200 and 300°C. Hafnium metal was produced by reduction of hafnium tetrachloride with magnesium at 800 to 950°C. Hafnium was separated from magnesium chloride in a vacuum still at 900 to 1,000°C. About 70% of the hafnium product met the specification (fraction) of the United States Atomic Energy Commission. Use of the electron-beam melting product resulted in a remarkable reduction in the amount of iron impurities in the hafnium, 50% reduction in oxygen, and a decrease in hardness to about seven-tenths the original value. (NSA of Japan)

Properties Evaluations

Refer also to abstracts 4415, 4716, 4754, 4755, 4841, 4846, 5215, and 5521.

4764 (CEA-R-3880) STUDY OF PLUTONIUM–SCANDIUM ALLOYS FOR THEIR APPLICATION IN THE MICROGENERATORS OF ENERGY. Ballagny, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1969. 60p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

The limits of the delta stabilized phase were precisely fixed between 4 and 17 at. % of scandium at room temperature. The coefficients of thermal expansion, the x-ray parameters, the density, and the electrical resistivity were measured for Pu-Sc alloys. The compatibility of these alloys with tantalum, oxidation behavior, and certain mechanical properties have been studied. (auth)

4765 (CISE-R-156) PRELIMINARY DATA ON THREE URANIUM TUBES COEXTRUDED WITH ZIRCALOY CLADDING. Topical Report No. 22. Bertoletti, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). Aug. 1965. Contract 005.63.7-NTRI. 12p. Dep. CFSTI (U. S. Sales Only).

Three uranium tubes coextruded with both external and internal Zircaloy-2 cladding were ordered from Nuclear Metals. The geometry was specified on the basis of the CIRENE reactor project studies. An outline of the evaluation tests contemplated for these three tubes is given. (auth)

4766 (CU-2660-11) THE SATURATED LIQUID AND VAPOR DENSITY OF CESIUM TO 3000 F, AND THE CRITICAL POINT OF CESIUM. Hochman, Jack M. (Atomics International, Canoga Park, Calif.); Bonilla, Charles F. (Columbia Univ., New York. Dept. of Chemical Engineering). [nd]. 9p. (CONF-690327-1). Dep. CFSTI.

From 3rd Symposium on Thermophysical Properties, Lafayette, Ind.

The volumes of the liquid and vapor phases of cesium in a vertical tube were found by passing direct current lengthwise along the tube and locating the liquid level by the IR drop. The test was carried out with three known weights of cesium and to temperatures above 3000°F. Simultaneous solution yielded the densities of the liquid and vapor phases as functions of temperature. The critical temperature of cesium was estimated at 3650°R by a reduced density comparison with mercury, in agreement with an earlier reduced electrical resistivity comparison. The predicted critical pressure is 130.8 atm abs and the density 0.451 g/cc. (auth)

4767 (N-69-36653) STATISTICAL ANALYSIS OF HIGH-TEMPERATURE CREEP-RATE DATA FOR ALLOYS OF TANTALUM, MOLYBDENUM, AND COLUMBIUM. Maag, William L.; Mattson, William F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. 23p. (NASA-TN-D-5424). CFSTI.

Empirical creep-rate equations are presented for the refractory-metal alloys T-111, T-222, TZM, TZC, D-43, and Nb-1Zr. These metals are considered potential structural materials for space power systems. The method of least squares was used to statistically analyze experimental creep data reported by other investigators. The form of the correlating equations is based on the theory that creep rate is a function of material temperature, stress, and structure. The equations cover a temperature range of 1256 to 1922°K and a stress range of 3.4×10^6 to 5.5×10^8 newtons/m^2. The variability associated with each correlating equation is expressed in terms of its standard deviation. (auth) (STAR)

4768 (N-69-36831) MECHANICAL BEHAVIOR OF TANTALUM-BASE T-111 ALLOY AT ELEVATED TEMPERATURE. Sheffler, K. D.; Sawyer, J. C.; Steigerwald, E. A. (TRW Equipment Labs., Cleveland, Ohio). Sept. 1969. Contract NAS3-9439. 27p. (NASA-CR-1436; ER-7365). CFSTI.

The tantalum-base alloy T-111 has been creep tested in an ultrahigh vacuum environment at temperatures and stresses chosen to provide approximately 1 percent creep in times up to 15,000 hours. Design data from five different heats are presented in the form of a Larson Miller plot for 1 percent creep life. Elevated temperature tension test data show a strain aging reaction in the 1400 to 2200°F range which produces unusual transient creep behavior. Values of activation energy and stress exponent suggest that steady-state creep of T-111 is governed by a diffusion controlled microcreep mechanism rather than by nonconservative dislocation motion. (STAR)

4769 (NP-18063) BIBLIOGRAPHY OF URANIUM ALUMINIDES (1948–1969). Jesse, A.; Ondracek, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Aug 1969. 48p. (In several languages). Dep. CFSTI (U. S. Sales Only).

The uranium aluminides UAl_4, UAl_3, and UAl_2 have been shown to play an important role in nuclear fuels. Thus there are numerous publications on alloys and compounds in the aluminum–uranium system. The following bibliography contains some 600 references, which have been mostly taken from Nuclear Science Abstracts (NSA) covering the period from 1948 to 1969. From the tables presented, references relevant to particular properties and materials may be obtained. The tables are subdivided into the aluminides UAl_2, UAl_3, UAl_4 and into aluminum and uranium-rich binary alloys, respectively, and UAl_4-Al dispersions. There is a further subdivision into the following: technology, structure, and properties of the above materials and their respective parameters. (auth)

4770 (ORNL-4440, pp 219-36) PHYSICAL AND MECHANICAL METALLURGY OF REFRACTORY ALLOYS. Patriarca, P. (Oak Ridge National Lab., Tenn.).

The solubility and diffusivity of N in W were determined to 1800°C. The transformation kinetics and the room-temperature mechanical properties of a Nb–54% Hf alloy aged between 600 and 1400°C were determined. The aging response is due to the precipitation of a fine dispersion of Hf-rich platelets. Spinodal curves, the wavelength of the modulated structure, and a time-temperature-transformation curve for a hypothetical alloy that transforms via spinodal decomposition and exhibits clustering were calculated from the free energy of mixing of binary alloys. The results show that better agreement would be obtained between theory and experiments at the equi-atomic concentration at about 0.5 of the critical temperature. The creep-rupture properties of T-111 stressed to 35,000 psi at 1205°C decrease with increasing temperature of the anneal before testing. At high stresses, T-111 annealed at 1650°C is weaker than T-111 annealed at 1200°C but it is stronger at low stresses. Graphite and Mo components were successfully fabricated into Cs evaporators by brazing with 47.5% Ti–47.5% Zr–5% Nb. The evaporators successfully operated above 1000°C for 200 hr. A compression test was developed for testing brazed joints in graphite. The electrical resistivity of Ta was measured to 2600°K, and an equation giving its temperature dependence to ±0.029 μΩ-cm is given. Development work continued on an electrical heating method for determining thermal conductivity. (auth)

4771 (ORNL-4440, pp 237-44) CLADDING MATERIALS FOR SPACE ISOTOPIC HEAT SOURCES. Patriarca, P.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.).

Creep-rupture data for five heats of Haynes alloy No. 25, including welded specimens, have been correlated from 650 to 1050°C by means of the Manson-Haferd parameter. Aging studies on this alloy have revealed a strength maximum and ductility minimum at 700°C which does not appear to be associated with the precipitation of Laves phase Co_2W. Charpy V-notch impact specimens of Haynes alloy No. 25, Hastelloy N, and Haynes developmental alloy No. 188 are being aged at 650, 700, 800, 850, and 900°C for times to 5000 hr and will subsequently be tested at room temperature and 760°C. Preliminary creep data on developmental alloys are the basis of predicted superiority of ordered alloys over both disordered developmental alloys and Haynes alloy No. 25. Long-range order was also shown to decrease evaporation between 950 and 1050°C. Initial evaporation of Ni, Co, and Fe from binary Pt alloys results in Pt enrichment at the surface that, in turn, decreases further evaporation. (auth)

4772 (RD/B/N-295) STRESS RELAXATION AND CREEP OF MAGNOX AL80. Gibbs, G. B. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). July 1964. 21p.

The temperature and time dependence of stress relaxation in polycrystalline Magnox AL80 deformed in tension were analyzed. Results were interpreted in terms of an exponential creep law and values of the creep parameters derived. The data were described by a model of thermally activated glide in which vacancy producing jogs were the obstacle to dislocation movement. Secondary creep measurements on Magnox and pure magnesium were also discussed and the information which they gave was compared with that from the relaxation experiments. (auth)

4773 INFLUENCE OF DEFECT STRUCTURE ON THE PROPERTIES OF SUPERCONDUCTING MATERIALS. Bauer, Charles L. (Carnegie-Mellon Univ., Pittsburgh). Emen, No. 3, 11-21(1969).

Characteristics of the magnetic structure of superconducting materials and interactions of this structure with defect structure, are considered. Metallurgical considerations associated with the development of nascent electrical and magnetic materials are outlined. Various techniques are used to investigate interactions with defect structure. As one example, recent anelastic investigations on Nb are reviewed, and their nature and significance indicated. The superconducting state is characterized by either complete flux expulsion or by partial penetration in the form of fluxoids. In the latter case, a periodic variation of the thermodynamic phase gives rise to energy gradients that can interact with defect structure. (Metals Abstr.)

4774 DUCTILITY OF ORDERED ALLOYS. Stoloff, N. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Emen, No. 3, 48-59(1969).

Mechanisms for embrittlement of ordered alloys are discussed and methods of promoting ductility are outlined. Changes in slip character may be produced by moving off the stoichiometric composition or by changing the ordering energy through ternary alloying additions. Grain boundary embrittlement may be alleviated by quenching from high temperature or by adding alloying elements to render ineffective the impurities responsible for boundary hardening. Substructure may be controlled through appropriate thermal-mechanical processing in order to improve both strength and ductility. If it is not possible to completely eliminate brittleness and notch sensitivity in ordered alloys, some may be used as reinforcing phases in directionally solidified eutectics, such as $Al-Al_3Ni$ or Co-CoAl. In such materials if the fibers fail, the ductile matrix can stop cracks and permit utilization of the composite alloy in situations where the single phase intermetallic cannot be used. (auth)

4775 ENVIRONMENTAL FACTORS AFFECTING THE MECHANICAL PROPERTIES OF URANIUM. PART I. THE EFFECT OF WATER VAPOUR. Hughes, A. N.; Orman, S.; Picton, G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater. 33: 159-64(Nov. 1969).

The mechanical properties of uranium have been tested in tension in controlled humid environments. The observed ductility of the metal is dependent on surface oxidation, prior heat treatment, and specimen shape in addition to humidity. The controlling influence of the first three factors is eliminated at sub-zero temperatures when a condensed film of water is formed on the specimen surfaces. The percentage reduction in ductility is reasonably independent of temperature over the range 0 to 75°C. (auth)

4776 COAGULATION OF THE PRECIPITATE OF THE INTERMETALLIC PHASES AND THE DIFFUSION FACTORS OF ALUMINUM, SILICON, AND IRON IN ALPHA-URANIUM. Novak, Jiri. Kovove Mater., 7: 196-8(1969). (In Czech).

An assessment was made of the effective diffusion factors of Al, Si, and Fe in α-U at 600°C. The diffusion factors increased in the sequence Al $\rightarrow$ Si $\rightarrow$ Fe. The diffusion factor of Al in α-U was close to the self-diffusion factor in α-U, the Si factor was ~20 times greater and the Fe factor ~3 times greater. These assessments are discussed by comparison with other known properties of the U-Al, U-Si, and U-Fe systems. (Metals Abstr.)

4777 DIFFUSION OF MOLYBDENUM, TUNGSTEN, AND VANADIUM IN IRON-CHROMIUM ALLOYS WITH A B.C.C. LATTICE. Kucera, Jaroslav; Million, Borivoj; Ciha, Karel. Kovove Mater., 7: 97-107(1969). (In Czech).

The diffusion of Mo, W, and V was measured in bcc Fe-Cr alloys with 0 to 26 wt % Cr. The activation enthalpies for diffusion of the individual elements did not systematically differ from one another in this composition range. Their concentration formation had a similar curve to that of the solidus of the system, with a minimum at 20 wt % Cr. For this system measurements of the diffusion characteristics for various elements showed large and improbable differences in the α solid solution range, requiring further measurements on pure materials to determine reliable characteristic values of migration processes. The concentration function of the diffusion factors can indicate some important phenomena, e.g., the effect of ordering processes on diffusion. No systematic deviations of the measured diffusion factors from the Arrhenius function were found, but the conclusion must not be drawn that the bcc Fe-Cr alloy is not among so-called anomalous materials, since the temperature range in which measurements were made was quite restricted. (Metals Abstr.)

4778 DETERMINATION AND EVALUATION OF SOME OF THE TRANSPORT COEFFICIENTS OF INDIUM ANTIMONIDE. Somogyi, Karoly (Research Inst. for Technical Physics, Budapest); Sidyakin, V. G. Hiradastechnika, 20: 262-9(Sept. 1969). (In Hungarian).

The temperature dependence of the resistivity and the Hall voltage (between room temperature and the temperature of liquid nitrogen, and between 77 and 300°K), of the thermal voltage, thermomagnetism, galvanomagnetism, and conductivity (between 77 and 300°K) was measured on several samples of indium antimonide single crystals. Tests were also conducted to establish the Nernst-Ettinghausen effects. The data provided information on the width of the forbidden band, the concentration of the majority charge carriers, and the effective mass of the majority charge carriers. A new method for measuring the mobility quotients was developed on the basis of the results obtained. (JPRS)

4779 THERMAL EMBRITTLEMENT OF CHROMIUM-NICKEL AUSTENITE-FERRITE WELD METAL AT AGEING TEMPERATURES BELOW 500°C. Ivanov, K. M.; Petrov, G. L. Svar. Proizv., No. 5, 1-4(May 1969). (In Russian).

Impact tests after aging treatment were carried out on five Cr-Ni steels containing Cr 17 to 20 and Ni 9 to 11% together with Mo, V, and Nb. In the Cr-Ni duplex weld metal, which contained >10% of ferrite phase, thermal embrittlement developed at comparatively low temperatures, in particular 250 to 260°C; this was reversible and could be completely eliminated by short-time heating above 500°C. Conditions to be fulfilled to restore the impact strength of the duplex metal, lost by aging or slow cooling below 500°C were: holding time below 500°C should be a minimum; and cooling should be rapid to avoid secondary embrittlement caused by these processes. The duplex Cr-Ni metal, even at high ferrite contents (~20%) had high impact and ductility properties for operational conditions in the range 200 to 500°C. Thermal embrittlement of austenite-ferrite during aging or slow cooling below 500°C did not seem to be a result of σ-formation. The beneficial effect of austenitization (tempering) on the sensitivity of the duplex metal to thermal embrittlement is associated mainly with the reduction in the quantity of ferrite in the weld metal. The beneficial effect of austenite decreased sharply with increasing quantities of ferrite in the original structure. Diffusion processes which cause embrittlement of Cr-Ni austenite-ferrite when aging or slow cooling below 500°C develop mainly in local boundary zones of the phase and are associated with the movement of crystal defects to the interphase boundaries, which leads to a weakening of the bond between the austenite and ferrite below 200°C. (Metals Abstr.)

4780 EFFECT OF CERIUM ON THE MECHANICAL PROPERTIES AND ELECTRICAL CONDUCTIVITY OF [99.99 PERCENT] ALUMINUM. Krupotkin, Ya. M. Izv. Vyssh. Ucheb. Zaved., Energ., No. 12, 111-13(1968). (In Russian).

Ce was shown to increase the strength of AV 000 (Al $\geq$ 99.99%)

significantly while maintaining high electrical conductivity. Ce additions raise the strength of technical purity Al (Al ≥ 99.5%), Ce 0.08% giving a UTS of 23 kg/mm^2 with an increase in electrical conductivity while retaining the high ductility. Ce additions improve the corrosion resistance of high-purity and technical Al. Ce additions of 0.08 to 0.10% have a significant effect on the properties of technical Al. (Referativnyi Zh.)

4781 ENVIRONMENTAL FACTORS AFFECTING THE MECHANICAL PROPERTIES OF URANIUM. PART II. THE MECHANISM OF THE WATER EMBRITTLEMENT OF URANIUM. Hughes, A. N.; Orman, S.; Picton, G.; Thorne, M. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater. 33: 165-72(Nov. 1969).

The embrittlement of uranium in water and water vapor environments has been studied in dynamic and static loading tests. The effects of pH in the range 1 to 13 on the water embrittlement of uranium are illustrated and discussed. Water does not embrittle uranium under high or low pH conditions, or at temperatures above 100°C. A mechanochemical mechanism involving the uranium–water reaction has been proposed to account for the observed embrittlement. (auth)

4782 DISTRIBUTION OF IRON AND ALUMINUM DURING ZONE MELTING OF URANIUM. Duzi, Pavel; Kuchar, Lumir. Hutn. Listy, 24: 437-41(June 1969). (In Czech).

The distribution of Al and Fe in the course of zone melting of U was investigated. Fe was distributed very uniformly, Al was not distributed. For a zone travel rate (R) = 2.22 cm/h, the effective distribution coefficient of Fe in U amounts to 0.36 ± 0.06. For comparison of zone-melting efficiency an equilibrium distribution coefficient of Fe in U was established. (Metals Abstr.)

4783 VARIOUS ASPECTS OF FRICTION IN LIQUID SODIUM. Morin, B. Mec. Elec., 52: No. 233, 33-8(May 1969). (In French)

Friction tests in a liquid Na environment at 150 to 600°C have shown the following: wear and friction are not related; the results depend markedly on temperature but only slightly on the load and speed of sliding; and the formation of surface oxide films, which act as solid lubricants, can explain some anomalies in the results. Materials tested included Cr and W carbides, stainless steels, Co and Ni alloys, and Mo on various base materials. (Metals Abstr.)

4784 ALLOYS OF ALUMINUM WITH LANTHANIDES FOR [INCREASED] SECONDARY ELECTRON EMISSION. Titova, A. S.; Shpichinetskii, E. S. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 27, 12-14(1968). (In Russian).

The possibility of using additions of lanthanides for preparing Al alloys with high secondary emission properties was studied. Raising the content of La in an alloy from 0.5 to 23.0% had no effect on the value of the secondary emission but the simultaneous presence of small quantities of Mg has a positive effect in this respect. (Referativnyi Zh.)

4785 HIGH TEMPERATURE ISOTHERMAL ELASTIC MODULI OF UO_2. Marlowe, M. O. (General Electric Co. Pleasanton, Calif.). J. Nucl. Mater. 33: 242-4(Nov. 1969).

The elevated temperature dynamic moduli of UO_2 were investigated in specimens containing additions of 1 wt % Gd_2O_3 of 4 wt % simulated solid fission products. The dopants had little effect on the values of the elastic moduli or their temperature dependence, but they did delay the rapid rise in internal friction usually associated with grain boundary sliding to higher temperature (about 1800°C for 1 wt % Gd_2O_3). Since the high values of internal friction make measurements by the dynamic technique impossible, results were obtained at higher temperatures than previously achieved. (J.C.W.)

4786 EFFECTS OF HYDROGEN ON THE TENSILE PROPERTIES OF URANIUM WHEN TESTED IN DIFFERENT ENVIRONMENTS. Adamson, P.; Orman, S.; Picton, G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater. 33: 215-24(Nov. 1969).

A novel method has been used for the introduction of accurate quantities of hydrogen into uranium which allows a wide range of concentration to be achieved without involving phase changes or quenching. The hydrogen embrittles the uranium and also makes the material susceptible to stress corrosion in air. At concentrations above 1 ppM platelets of uranium hydride form preferentially in certain crystallographic directions. The platelets are not preferentially associated with grain broundaries. The effects of hydrogen content, temperature, and testing environment on the mechanical properties of hydrided uranium are reported and a mechanism proposed. (auth)

4787 MATERIAL AND HEAT TREATMENT FOR SINTERED METAL TOOLING [AND DIES TO BE USED FOR POWDER METAL PROCESSING]. Harvey, Richard F. ASTME Paper No. EM69-549. Dearborn, Mich., American Society of Tool and Manufacturing Engineers, 1969. 11p.

Heat treatment and its effects on hardness, toughness, wear resistance and related properties of a variety of C, alloy, tool, and stainless steels, grouped into the categories of cold work die steels, hot work steels and high-speed steels is discussed. The features of a cemented carbide consisting of 11% Co and 89% WC that make it suitable for tools for compacting powder metal parts are noted. The factors governing the choice of tool materials are indicated. Recent metallurgical developments which are related to tooling for use on powder metals include: thermomechanical treatment of tools, matrix steels, pinpoint carbides (incorporated in high-speed steel), precipitation-hardening carbides, high-speed steel of ultrafine grain size and low-cost precipitation-hardening steels and tools that are made of powder metal. (Metals Abstr.)

4788 THERMAL CONDUCTIVITIES OF MOLYBDENUM AND TUNGSTEN KNITMESH PELLETS USED IN NUCLEAR FUEL PINS. Howl, D. A. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Nucl. Mater. 33: 138-48(Nov. 1969).

An apparatus for determining the effective thermal conductivities of knitmesh pellets in vacuo or inert gas atmospheres is described. Results from two hundred and forty-five determinations for molybdenum and tungsten pellets in the temperature range 30 to 200°C are reported. An equation, derived from a simple theoretical model, gives good agreement with the experimental results so that extrapolation to higher temperatures or different gas atmospheres is possible. The effective conductivity is only weakly dependent on the gas pressure and is independent of the packing density of a pellet except at high packing densities. (auth)

4789 X-RAY DIFFRACTION STUDY OF THE EFFECTS OF UNIAXIAL PLASTIC DEFORMATION ON RESIDUAL STRESS MEASUREMENTS. Esquivel, A. L. (Boeing Co., Seattle). Advan. X-Ray Anal., 12: 269-300(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Uniaxial Plastic Deformation (UPD) has been known to produce anomalies in residual stress measurements based on x-ray diffraction techniques. The magnitude of the effects, if any, on residual stress calculations from various materials subjected to UPD was studied. An x-ray diffraction study using the two-exposure method ($\psi = 0°$ and $\psi = 45°$) was made on several iron, aluminum, and titanium alloys (AISI 4340, 4330M, 4130; 2024-T3, 7075-T611; Ti–6Al–4V) before and after these alloys were deformed plastically by bending on a U-bend test fixture. The x-ray peak shifts, $\Delta 2\theta_{0-\psi}$, were recorded and the x-ray stress factors, K_1, calculated by three different methods. The results indicate that UPD of the calibration specimens will increase or decrease K_1 depending on the alloy. These results are discussed together with observations on the additivity of residual and applied stresses, and the per cent differences in the stress measurements based on stress factors calculated by three different methods. (auth)

4790 ROLE OF RESIDUAL STRESSES AS DETERMINED BY X-RAY DIFFRACTOMETRY ON MAGNETIC PROPERTIES OF 4-79 MOLYBDENUM PERMALLOYS. Bhattacharyya, A.; Darling, H. E. (Foxboro Co., Foxboro, Mass.). Advan. X-Ray Anal., 12: 301-15(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Residual stresses in several batches of heat-treated 4-79 molybdenum Permalloy finished laminations were measured by x-ray diffraction technique. This involved determination of macrostresses from line shift of (331) reflection by the two-exposure diffractometric technique as well as the determination of microstresses from half breadth of the same line profile. It was observed that the residual stresses in all batches of laminations were small and the variations in residual stresses from one batch of laminations to another were not appreciable, considering the scatter in laminations within each individual batch. Simultaneous magnetic measurements showed considerable variation in magnetic properties from batch to batch; e.g., a five-fold variation in normalized hysteresis loop and a two-fold variation in the magnetic softness parameter. On subjecting individual batches of laminations to various thermal and thermomagnetic treatments below 650°C, considerable change in magnetic properties was achieved without significantly changing residual stresses. The variation in magnetic properties in finished laminations was ascribed to the difference in effective crystal anisotropy and uniaxial anisotropy caused by variations in thermal and thermomagnetic annealing treatments. The study showed that the variation was not due to any major variation in stress induced magnetostrictive anisotropy. (auth)

4791 DETERMINATION OF PARTICLE SIZE DISTRIBUTION IN A DISPERSION HARDENED NICKEL ALLOY USING SMALL ANGLE X-RAY SCATTERING. Gould, R. W.; Bates, S. R. (Univ. of Florida, Gainesville). Advan. X-Ray Anal., 12: 87-96(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

It has been recently shown that particle size distributions can be determined from small angle x-ray scattering data. Size distributions have previously been measured in aluminum-zinc and aluminum-silver alloys containing spherical Guinier–Preston zones. In order to obtain the size distribution it was only necessary to calculate the Guinier radius and the Porod radius. Dispersion hardened nickel alloys containing small spherical particles of thoria appear to be amenable to this type of analysis. A nickel–20% chromium–2% ThO$_2$ alloy was selected for this study. The particle size distribution obtained by small angle x-ray scattering is compared with the transmission electron microscopy results found in the literature. (auth)

4792 MATERIALS FOR THE NUCLEAR POWER INDUSTRY. Edstroem, J. O. (Sandvikens Jernverks AB, Sweden). Tek. Tidskr., 99: 777-81(1969). (In Swedish).

The requirements of materials for use in reactor technology are discussed. The properties of zirconium and nickel alloys and stainless steels are briefly described. The material selection for different nuclear reactor components is reviewed. (Sweden)

4793 DIFFUSION AND TRANSPORT PROCESSES IN AND ON TUNGSTEN. Neumann, G. M. (OSRAM-Studiengesellschaft, Augsburg, Ger.). pp 86-107 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The results of a study of the transport processes in tungsten surface diffusion, grain boundary diffusion, volume diffusion, electron transport, and thermotransport are reported. Data on failure mechanisms and formation and migration energy of vacancies were compiled and are discussed. It was shown that the surface diffusion study results can be explained on the basis of the Stranski–Suhrmann model by consideration of the different configurations of the atoms during the diffusion processes. For the explanation of the results of the volume diffusion studies it can be shown that the assumption of a diffusion mechanism for the formation and migration of single and double vacancies is compatible with the experimental results. (tr-auth)

4794 GRAIN BOUNDARY DIFFERENCES IN MOLYBDENUM AND TUNGSTEN: THEIR INFLUENCE ON SOME PROPERTIES OF THESE METALS. Krumphold, R. (Institut fuer Metallische Spezialwerkstoffe, Dresden). pp 138-58 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The existence of intercrystalline oxide and carbide precipitates was confirmed by microfractographic studies on molybdenum and tungsten. MoO$_2$ or WO$_2$ could be detected on the intercrystalline fracture faces by electron diffraction both in sintered and molten metals without deoxidation medium. If carbon was added in excess to the melt as the deoxidizing agent, the diffraction lines are assigned to the carbides Mo$_2$C and W$_2$C. Repeatedly supplementary low intensity MoO$_2$ reflexes occur. With the formation of the carbides along the grain boundaries in large crystalline textures, an adequate heat and cold workability occurs. Analogous results are obtained when boron is used for the deoxidation of the molybdenum melt. The satisfactory workability of the sintered and with molten metals with grain refining additions was traced back to the fine-grain texture and, therefore, to a favorable distribution degree of the oxide phase. The low strength of the rolled polycrystalline molybdenum perpendicular to the rolling plane and its laminar fracture inclination were regarded as a result of the laminar arrangement of the oxide and carbide precipitates in the deformed structure. The results of the microfractographic and diffraction studies confirmed this assumption. (tr-auth)

4795 THE INFLUENCE OF ANNEALING ON THE RECRYSTALLIZATION BEHAVIOUR AND THE MECHANICAL PROPERTIES OF DOPED AND UNDOPED MOLYBDENUM WIRE. van Meel, F. A. M. M.; van Maaren, A. C.; van Weezel, G. J. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). pp 172-81 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The recrystallization behavior of tungsten and molybdenum wire is strongly influenced by the presence of dope and by the amount of dislocations dependent on previous deformation and annealing. A working model for the recrystallization behavior of doped tungsten and molybdenum is proposed. In this working model the influence of dope and the amount of dislocations is combined. (auth)

4796 HARDENING OF SOME MOLYBDENUM-BASED ALLOYS BY PRECIPITATION OF NITRIDE AND CARBIDE PHASES. Ryan, N. E.; Martin, J. W. (Oxford Univ.). pp 182-207 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The feasibility of classical precipitation-hardening by quench-aging treatments has been demonstrated in molybdenum, using carbides or nitrides of the Group IVa elements. Alloys of the following compositions have been produced and heat-treated: Mo–Ti–c, Mo–Ti–N, Mo–Zr–C, Mo–Zr–N, Mo–Hf–C, and Mo–Hf–N. The alloys were prepared by introducing the Group IVa elements and carbon or nitrogen into the molybdenum, such that 1 vol % of the relevant carbide or nitride was present. For comparative purposes, a commercially produced molybdenum TZC was quench-aged and examined in a similar way to the experimental alloys. The alloys were solution-treated for 1 hr at 2100°C, followed by quenching to room temperature at a rate of 200°C sec^{-1}, and subsequently aged at 1200, 1350, and 1500°C for periods of up to 100 hr; age hardening curves have been plotted. Thin foil specimens for electron microscopy have been prepared from each alloy at different stages of aging, and in most cases the mode of precipitation has been clearly established. Similar patterns of precipitation behavior were observed at each aging temperature. It was found that the carbides and nitrides of both Hf and Zr precipitate as plates with {100} habit planes. The Zr compounds both appear to precipitate preferentially on matrix dislocations, whereas the Hf compounds are more widely distributed. The titanium carbide and nitride precipitates do not exhibit a low index habit plane. The formation of the titanium carbide phase was observed during aging to be accompanied by the progressive decomposition and resolution of residual particles of molybdenum carbide, and this behavior has been correlated with the form of the age-hardening curve. The precipitation sequence in the Mo–TZC alloy was closely similar to that observed in the simple Mo–Ti–C alloy, with the important distinction that the habit plane of the complex carbide precipitate was {100}. It is concluded that it is the influence of the zirconium in the Mo–TZC which dictates the habit-plane selected by the precipitate. (auth)

4797 ELEVATED TEMPERATURE DEFORMATION AND FRACTURE OF A PRECIPITATION HARDENED MOLYBDENUM ALLOY. Wilcox, B. A.; Gilbert, A.; Allen, B. C. (Battelle Memorial Inst., Columbus, Ohio). pp 208-27 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The deformation and fracture characteristics of molybdenum-TZM (Mo–0.5 Ti–0.1 Zr–0.001 to 0.019°C) have been studied over the temperature range 200 to 1850°C, with emphasis on evaluating the influence of strain rate, structural condition, and carbon content on the mechanical behavior. Three alloys, containing 10, 100 and 190 ppM of carbon, respectively, were evaluated in both the wrought-stress-relieved and recrystallized conditions at tensile strain rates of 0.01, 2 and 600 min^{-1}. The yield and ultimate strengths of the wrought-stress-relieved alloys decreased continuously with increasing temperature. However, for recrystallized alloys it was found that dynamic strengthening occurred in the temperature range ~1000 to 1650°C. This resulted in strength peaks, which were much more pronounced in the two higher carbon alloys than in the alloy containing 10 ppM C. This effect is attributed to dynamic precipitation of carbides during deformation. Associated with the strength peaks was a marked ductility decrease caused by severe grain boundary cracking. This effect is rationalized phenomenologically in terms of the relative shear strengths of the matrix and the grain boundaries. In the range ~1000 to 1650°C, grain boundary sliding leads to intergranular cracking and the cracks propagate to failure. At higher temperatures the cracks still form, but dynamic recrystallization assists in blunting them and high ductilities are obtained. (auth)

4798 NEW EMISSION ELECTRON MICROSCOPE FOR HIGH-TEMPERATURE INVESTIGATIONS. Wegmann, L.;

Zaminer, Ch. (Balzers AG., Truebbach, Ger.). pp 1079-90 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

A review is given of the present application of the emission electron microscope at high temperatures. The application limits of the various electron resolution mechanism were discussed. The new photoemission electron microscope Balzers METIOSKOP KE3, developed on the basis of present knowledge was described. Two examples of the observation of the grain growth in the emission electron microscope were given. In the first the kinematic recording of the recrystallization phenomena of tungsten at 2000°C was reported. In the second the texture changes of copper during heating to 450°C was described on the basis of photoemission pictures. (tr-auth)

4799 CREEP BEHAVIOR OF IRON–MOLYBDENUM ALLOYS IN THE TEMPERATURE REGION FROM 500 TO 1000°C. Fuchs, A.; Ilschner, B.; Uelze, D. (Univ., Erlangen, Ger.). pp 1034-56 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Tensile samples from vacuum melted carbon-free iron–molybdenum alloys with up to 15 wt % Mo was deformed in the temperature range from 500 to 1000°C at constant load under a protective gas and the deformation was measured continuously as a function of time. The evaluation of the creep curves so obtained was much improved since the creep rate was distributed logarithmically against the respective expansion. Load and temperature variations permit with this method very detailed data on the stress and temperature dependence of the stationary creep rate. The activation energy (Q) of the creep agrees only at temperatures over 850°C with 65 kcal/mole with that found for the diffusion in the Fe–Mo system; at lower temperatures it is much higher (about 100 kcal/mole). At the Curie point an anomaly of the temperature pattern of Q is found which cannot be explained by the T dependence of the shear modulus. The increase of the creep rate with the charge can be represented only within a narrow stress range approximately by a power function, in which the exponent n for small values of σ/kT takes the value 4. With increasing stress the creep rate increases exponentially with σ/kT, measured over a wide range. The activation volumes, and therefore the stress dependence, decreases with increasing Mo content. At maintained temperature and stress, the creep rate was reduced by molybdenum additions to the mixed crystal range, for example at 785°C, by a factor of ten, in the two phase range by ten powers of ten with respect to the value for pure iron. Data were also given on grain boundary effects, transition creep, recrystallization, and recovery. (tr-auth)

4800 ROLE OF REFRACTORY METALS IN AUSTENITIC SUPERALLOYS. Sims, Ch. T. (General Electric Co., Schenectady, N. Y.). pp 514-38 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

A study of the effects of refractory metal additions on the structure and properties of austenitic superalloys has been conducted. Refractory metals have been added to these alloys in increasing amounts as the technology has developed. As their strengthening effects were realized and exploited, amounts up to 10 wt % in Ni forging alloys, 14 wt % in Ni casting alloys, and 15 wt % in Co alloys were reached. However, as the mechanisms by which these alloys are strengthened has become more well understood, typical additions to contemporary alloys have become optimized at about 6 to 8 wt % in Ni alloys and 10 to 12 wt % in Co alloys. Refractory-metal atoms enter virtually all the phases present in austenitic superalloys, exerting in total a profound and provocative effect on strength and structure. They enter the structure of most of the carbides present in these alloys, controlling the morphology and stability, even when not the major atom present in the carbide. In addition, it has recently become realized that the Group VIA elements substitute in the structure of the vital geometrically close packed (gcp-type) phases (fcc γ') in Ni-base alloys, in proportions roughly equivalent to their level in the alloy as a whole. Also, Group VA elements may concentrate in the gcp phases. Particularly as evidenced in Co-base alloys, refractory metal atoms cause considerable strengthening through normal solid solution effects related to atom size mismatch and to their concentration. A relatively simplified method of viewing the phase relations involved is exploited through use of polar phase diagrams. These diagrams have the capability of integrating the phase relations of four or more elements at constant temperature. When considerable amounts of refractory metal atoms are added, the electron hole concentration is driven upward (higher N_v number). As dictated by phase relations, excessive additions of refractory metal atoms then cause the alloy matrix composition to exceed the limits of the austenitic fcc γ, precipitating one or more of the quaternary centroidal topologically close packed (tcp) phases. These latter phases, usually hard electron or size compounds, deplete the alloy of strengthening refractory metal atoms (and chromium). Probably in combination with mechanical effects, this depletion causes severe loss of rupture capability and promotes the low-temperature ductility. (auth)

4801 PROPERTIES OF SUPERALLOYS MADE BY HOT WORKING OF PREALLOYED POWDERS. Parikh, N. M. (Illinois Inst. of Tech., Chicago). pp 500-13 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Melts of superalloys such as Inconel 713C, PH 15-7 Mo, and Udimet 700 were converted into high purity powders. The powders were then converted into wrought materials by hot extrusion or hot forging. Results of mechanical property measurements of the wrought products indicate that the products fabricated from powders are superior to those made from castings. Particularly, the powder metallurgy T-section of Inconel 713C shows almost a two-fold improvement in moderate temperature (up to 1400°F) tensile properties over the cast alloy. The other alloys were comparable in properties to the commercial wrought products but showed a greater ease of fabricability. The effects of fabrication variables on properties are also described. (auth)

4802 THE EFFECT OF CARBIDES ON THE MECHANICAL PROPERTIES OF TWO NIOBIUM-BASE ALLOYS. Kelcher, R. W.; Carter, A. pp 341-4 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Data obtained in studies of SU 16 (Nb–11W–3Mo–2Hf–0.08C) and SU 31 (Nb–17W–3.5Hf–0.12C) are reported. The effects of grain-boundary carbides on ductility, and the effects of heat treatments on creep strength at 1200°C and tensile strength at 600°C were investigated. (J.R.D.)

4803 ROLE OF INTERSTITIALS IN REFRACTORY METALS AND THEIR ALLOYS. Szkopiak, Z. C.; Ahmad, M. S. pp 345-56 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The effects of small additions of substitutional solute atoms on the room temperature mechanical properties and the internal friction spectrum of Nb containing O and N were investigated. The possibilities of relating internal friction effects with mechanical properties are examined. The materials used in the investigation were refined Nb, and the refined dilute Nb-base alloys Nb–Mo, Nb–Fe, and Nb–Zr. The interaction processes between substitutional and interstitial atoms and their contribution to the strength of these alloys are emphasized. (J.R.D.)

4804 DISLOCATION DYNAMICS IN STRESS RELAXATION. Gupta, Indra. New York, N. Y.; Columbia Univ. (1968). 77p. Thesis.

Stress relaxation was studied in LiF, NaCl, niobium, tantalum, vanadium, iron-3.2% silicon alloy, iron, molybdenum and tungsten. A nonlinear relation between stress and logarithm of time was observed in the stress relaxation of all these materials. By making the usual assumption that density of mobile dislocations and long-range internal stress remain constant during stress relaxation, a three-parameter relation derived on the basis of Gilman and Johnston's dislocation velocity-stress relation seems to explain the stress relaxation behavior of all the materials studied. The values of dislocation velocity-stress exponent (m^*) were calculated for all the materials and found to be in agreement with those obtained by etch pit technique wherever available. For NaCl the value of m^* increased with strain whereas the values of m^* for less pure niobium and tantalum decreased with strain. For other materials the value of m^* remained constant with strain. The values of m^* showed no strain rate dependence. The values of long-range internal stress and effective stress were calculated from the stress relaxation data, and it was found that increasing long-range internal stress is mainly responsible for work hardening. On the other hand, increasing effective stress is mainly responsible for low temperature hardening of bcc metals. The activation volumes obtained from the stress relaxation results showed good agreement with those obtained by strain rate cycling. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstracts 4804, 5205, and 5214.

4805 AN INTERNAL FRINCTION STUDY OF THE ALLOTROPIC TRANSFORMATIONS OF PLUTONIUM, URANIUM, AND COBALT. Selle, James E.; Focke, A. E. (Mound Lab., Miamisburg, Ohio). Nucl. Mater. 33: 149-58(Nov. 1969).

Consistent correlations on plutonium, uranium, and cobalt have been made which suggest that internal friction and relative shear modulus measurements can be used for the classification of the mechanisms of allotropic transformations. Diffusional transformations were characterized by the fact that the internal friction values of the parent and product phases were considerably different at the transformation temperature and the relative shear modulus changed over a very narrow temperature range of 2 to 3°C. Shear transformations were characterized by the fact that the internal friction values above and below the transformation temperature were approximately equal, and the relative shear modulus changed over a broad temperature range. Possible interpretations for these observations are given. In addition, features of the steady state internal friction curves of plutonium, uranium and cobalt are discussed. (auth)

4806 PREPARATION OF SOUND HIGH PURITY PLUTONIUM RODS. PART II. OBSERVED PHASE TRANSFORMATIONS DURING QUENCHING FROM ELEVATED TEMPERATURES. Harbur, D. R.; Flemings, M. C.; Anderson, J. W.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater. 33: 195-207 (Nov. 1969).

Cooling curves of high purity plutonium chill cast from the liquid and quenched from high temperature solid phases have been subjected to heat flow analysis to yield information concerning the transformation behavior of the rapidly cooled material. The most complex transformation behavior was found in rods formed when molten plutonium was chill cast into molds at ambient temperature. The plutonium solidified as ϵ phase and the bulk of the material subsequently transformed to γ, then to β and finally to α phase during the cooling process. When the mold temperature was −72°C prior to the pour, the ϵ phase material transformed to α phase at a temperature of 80°C. High density α phase rods were heated into and then quenched from β, γ, and δ phase fields. The high temperature phases which were formed then transformed to α phase below 90°C. If the formation of the brittle α phase proceeded from the circumference of the rod toward the center, a relatively crack-free rod was produced. However, if the formation of α phase occurred randomly across the cross section, a badly microcracked rod resulted. (auth)

4807 AUTHOR'S REPLY: THE HABIT PLANES OF ZIRCONIUM HYDRIDE IN ZIRCONIUM AND ZIRCALOY. Westlake, D. G. (Argonne National Lab., Ill.). J. Nucl. Mater. 33: 245-6(Nov. 1969)

A rebuttal is given to a paper published previously and abstracted in NSA as 23: 8235, which was a rebuttal to a paper published previously by the present author and abstracted in NSA as 22: 28957. (J.C.W.)

4808 CHANGES IN THE BRAGG-WILLIAMS PARAMETER WITH DEFORMATION IN ORDERED Au_4V. LeFevre, B. G.; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta). Advan. X-Ray Anal., 12: 113-28(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

The intermetallic compound Au_4V is known to be ferromagnetic at temperatures below 43°K. Its ferromagnetism, which has been attributed to long range order, can be destroyed by cold deformation. The present study was undertaken to determine how the Bragg and Williams long-range-order parameter of the fully ordered alloy varied as a function of deformation by cold rolling. Because of complexities in the diffraction spectrum it was not possible to determine S by a simple ratio of integrated intensities as is frequently done in other ordered systems. A treatment was developed to handle these difficulties using a modification of a method for determining volume fractions of mixed phases. These results are correlated with magnetic measurements. (auth)

4809 CLOSE-PACKED ORDERED ALLOYS. Beck, Paul A. (Univ. of Illinois, Urbana). Advan. X-Ray Anal., 12: 1-21(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Systematic procedures are used for generating the geometrically possible close-packed ordered layers for any desired binary ideal composition and the various geometrically possible stacking sequences with a given number of layers of known structure. The known ordered close-packed crystal structure types in AB_3 and AB_4 alloys are characterized by the structure of the layer and by the stacking sequence. Their occurrence is reviewed in relation to pertinent variables, such as electron concentration and atomic size. (auth)

4810 NATURE OF QUENCHED URANIUM TEXTURE. Zelenskii, V. F.; Krasnorutskii, V. S.; Kunchenko, V. V. At. Energ. (USSR); 27: 411-15(Nov 1969). (In Russian).

The effect of external stress on the texture of quenched uranium was analyzed. It was found that the external expansion stress applied to the uranium rod during the quenching contributed to the increase of texture component of the [010] type in the direction of the applied forces; but the compressive stress contributed to the increase of the texture component of the [100] type. A mechanism for texture formation during quenching is proposed. (auth)

4811 EXAMPLES OF DETERMINATION OF EQUILIBRIUM PHASE DIAGRAMS OF SYSTEMS OF REFRACTORY METALS. Allibert, C.; Driole, J.; Bonnier, E. (CNRS, Grenoble, France). pp 228-36 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In French).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Two examples of the determination of phase equilibrium diagrams of refractory metal systems are presented. These determinations result from two different studies: the metallurgical separation of niobium−tantalum and the development of niobium−tungsten solid solutions from a ternary liquid metallic solution. Diverse considerations were imposed by the third element copper. The experimental technique used is the partition method which consists of separating the immiscible phases by density and analyzing them after solidification. In order to facilitate the mechanical separation of the phases in equilibrium, delicate because of their slight difference in density and the high values of the surface tensions, high temperature centrifugation was used. Different isotherm sections were then presented. In the case of the Cu−Nb−Ta diagram, a ternary miscibility gap was noted. A tentative representation in the space of the partial diagram between 1900 and 2100°C was made. In the case of the Cu−Nb−W diagram, the curve of an isotherm section at 1900°C made it possible to make more precisely identifiable the conditions allowing the preparation of a Nb−W solid solution of predetermined composition. (tr-auth)

4812 ON THE PRECIPITATION BEHAVIOR OF NIOBIUM ALLOY D-43 (Nb-10W-1Zr-0.1C). Ostermann, F.; Bollenrath, F. (Air Force Materials Lab., Wright-Patterson AFB, Ohio. Technische Hochschule, Aachen). pp 317-40 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The formation of precipitate phases in niobium alloy D-43, nominal composition Nb−10W−1Zr−0.1C, was investigated by metallography and x-ray diffraction analysis of chemically extracted phases. Complete solution of carbide phases occurred at and above 1650°C. The time and temperature dependence of precipitation of the equilibrium carbide phase, a zirconium-rich monocarbide (Zr,Nb)C, was shown to be influenced by the cooling rate after solution annealing. This effect is apparently caused by nonequilibrium niobium carbides which precipitate during cooling from high annealing temperatures. The reduced room temperature ductility of alloy D-43 in the solution annealed condition was attributed to the precipitation of apparently Nb_2C at grain boundaries. The improvement of room temperature ductility during aging seems to be related to the dissolution of the carbide phase at grain boundaries. Precipitation of metastable niobium carbides prior to the formation of (Zr,Nb)C depletes the matrix of carbon supersaturation and, therefore, reduces the driving force for (Zr,Nb)C precipitation. The nucleation of the (Zr,Nb)C particles seems to be strongly dependent on the availability of carbon, and the result is a nonuniform distribution of stable (Zr,Nb)C precipitates. Evidence of increasing carbide solutioning was found after heating at temperatures above 1200°C, hence coagulation of equilibrium carbides can be expected in this temperature range. (auth)

4813 REACTION DIFFUSION BETWEEN TWO METALS INCLUDING TITANIUM AND NIOBIUM. Rieck, G. D.; Bastin, G. F.; van Loo, F. J. J. (Technological Univ., Eindhoven, Netherlands). pp 357-71 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Two metals in contact with each other at an elevated temperature interdiffuse. In those cases in which one or more intermetallic compounds are formed during this process it may be called reaction diffusion. The intermetallic compounds may have unusual mechanical and chemical properties and may be used as coatings. Formulas given by Boltzmann, Matano, Heumann, and Wagner make possible the calculation of diffusion coefficients from the observed concentration gradients. If the intrinsic diffusion coefficients are not equal (which means that one of the components diffuses more rapidly than the other) a Kirkendall effect occurs, resulting in shrinkage of one of the phases or in the formation of pores. A technique of diffusion couples and a modification of the calculation method were used to determine the layer growth characteristics in the Ni–Al system. Owing to the great stability of the intermetallic phases, it depends on the nature of the diffusion couple whether Al or Ni is the moving atom. The Ti–Al, Ti–Ni, and Nb–Al systems are under investigation. Preliminary results in the Ti–Al system indicate that up to 650°C it is only $TiAl_3$ that grows. All other layers grow regularly above 700°C. In Ti–Ni, the TiNi layer is the thickest and regular in shape and so are layers of $TiNi_3$ and Ti_2Ni. Above 720°C a new layer of a solid solution of Ni in Ti grows very rapidly. In the Nb–Al system, the first compound formed is $NbAl_3$, which grows very slowly below 630°C, and only above the melting point of Al reasonable layer growth occurs. A Nb_2Al layer grows at 1200°C according to the parabolic law. (auth)

4814 A FRATOGRAPHIC STUDY OF PRECIPITATION HARDENED AND DISPERSION STRENGTHENED MAGNESIUM-BASE ALLOYS. Calhoun, Clyde D. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 189p.

Thesis.

The fracture characteristics of Mg–3.7Th–0.4Zr and of Mg–0.6Zr have been investigated. The ternary alloy is a precipitation hardenable system exhibiting a coherent transition precipitate while the binary alloy forms a stable dispersion of Zr hydride when heated in an atmosphere of hydrogen. The ternary alloy was investigated in four different heat treated conditions which provided two levels of yield stress. The solution treated condition and an overaged condition provided one level of yield stress, while the other yield stress level was attained by interrupting the heat treatment prior to optimum aging and by slightly overaging. It was not possible to obtain the same yield stress level with different heat treatments for the binary alloy, which was examined in the hydrided and solution treated conditions. Specimens were fractured at −196, 23, and 210°C by tensile testing at a strain rate of 1.4×10^{-2}/min. Further information concerning the influence of mechanical twins on fracture and the initiation of microvoids was acquired by differential temperature tests, where specimens were deformed at one temperature to a predetermined strain, followed by deformation to fracture at another temperature. The temperatures involved in the differential temperature tests were the same as those referred to previously. Notched tensile specimens were tested at 23 and −196°C at a cross-head rate of 0.02 in./min and tensile specimens with a single edge notch were strained at 23°C in a special jig so as to permit arrest of a propagating crack. Fractographic analysis of the notched tensile specimens revealed: (1) that dimples can form in the absence of necking, and (2) fractographic features indicative of cleavage. The crack arrest studies revealed that crack propagation progressed without microvoid coalescence. Stress-rupture tests were carried out on the ternary alloy in the most severely overaged condition and on the binary alloy in the hydrided condition. No significant differences in fractographic features from tensile samples broken at the same temperature were observed. Two stage replication of the fracture surface and subsequent examination with the electron microscope was accomplished on all fractured specimens in order to determine the mode of failure and the influence of precipitate and hydride particles on the fractographic features as a function of temperature and specimen condition. Of particular interest was the determination of the mechanism of formation, size and distribution of dimples as a function of metallurgical condition. In addition, direct carbon extraction techniques were employed to study size, distribution and morphology of precipitate and inclusion particles. The propensity for twinning and the initiation and degree of porosity were determined as a function of temperature, microstructure, and strain by polishing tensile specimens to their longitudinal centerline and examining the microstructure by light microscopy. Cracks were often found to propagate along twin bands, but no clear evidence was obtained for twin initiated crack propagation. In nearly all cases where particles were responsible for initiation of voids in Mg–Th–Zr, the particles themselves fractured, rather than the particle-matrix interface. While voids were formed at the sites of particle fracture, the voids did not grow substantially in either the transverse or longitudinal directions prior to or during fracture. It was found also that dimple sizes measured on fractographs were at least an order of magnitude smaller in size than voids seen by light microscopy. It was therefore concluded that fracture of these Mg alloys did not occur by microvoid coalescence; this is in disagreement with a widely accepted theory of ductile fracture. Although particles were frequently observed to be associated with dimples on electron fractographs, dimples were also observed in the absence of particles. A mechanism for the formation of cusps (dimples) is described which is common to all plastic solids, whether or not particles are present. (Disser. Abstr.)

4815 MORPHOLOGY OF EXPLOSIVE WELDS. Dassu, G.; Alessandrini, G. (Politecnico, Milan). Met. Ital.; 61: 435-41 (Sep 1969). (In Italian).

The efficiency and the structure of the bond obtained between two metals joined by explosive welding was morphologically examined. The following welds were examined: stainless steel AISI 304 L/Zircaloy-2, steel UNI C10/Zr-Nb (2.5% Nb), and Zircaloy-2/Zircaloy-2. The same metallographic tests on 304L/Zircaloy-2, welded by hot hammering, were also completed. Great accuracy and special techniques were employed in metallographic surface preparation. Morphological data on explosive welds confirm the results of mechanical and gas permeability tests, while showing that a substantial difference exists in respect to hot hammer welds. (auth)

Radiation Effects

Refer also to abstract 5507.

4816 (EURFNR–698) IRRADIATION-INDUCED BIAXIAL CREEP BEHAVIOR OF FUEL-ELEMENT CLADDINGS FOR FAST REACTORS: EXPERIMENTAL AND THEORETICAL RESULTS. Laue, H. J.; Closs, K. D.; Guyette, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). July 1969. 27p. (KFK–1017; EUR–4180; CONF-690620–5). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Damage in Solids and Reactor Materials, Vienna, Austria.

In-pile stress rupture tests of stainless steel, Incoloy 800, and Hastelloy X are described. Results are presented which may be considered a first step towards a complete stress analysis of the fuel element cladding of a high-power reactor. Sufficient results from well defined in-pile stress rupture and creep tests are required for such a theoretical analysis. The fast neutron flux should be as high as possible for such experiments. The method described should be sufficient for a first fuel element concept. Neutron irradiation is the predominant effect and the lifetime of the fuel element cladding is reduced by irradiation between 55% and 15%, depending on the material used and the test conditions. On the other hand, thermal stresses and a reduction of the wall thickness due to anticipated corrosion do not greatly influence the reduction of lifetime, whereas the pressure increase due to fission gas release and swelling of the fuel leads to a remarkable increase of the operation time compared with experiments at constant inner pressure. (auth)

4817 (GAMD–9393) PEACH BOTTOM REACTOR VESSEL IRRADIATION SURVEILLANCE PROGRAM. IMPACT TEST RESULTS ON CHARPY SPECIMENS AT NOZZLE ACCESS PLUG AFTER 300 EFPD. Hildebrand, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). 6 Jun 1969. Contract AT(04-3)-314. 27p. Dep. CFSTI.

Charpy impact specimens representing both the plate and plate-welds of the Peach Bottom Atomic Power Station reactor vessel were tested after exposure for 300 equivalent full power days (EFPD) at the nozzle access plug location. The fluence as measured by the attendent dosimeter was approximately 5×10^{8} n/cm^2, which compares reasonably well with the predicted fluence of 1.6×10^{8} n/cm^2 (E > 1 MeV). The test results indicate that there has been no significant change from the NDT temperature reported for the control specimens. The serviceability of the reactor vessel is considered to be unimpaired by the radiation dose received during this period of reactor operation. (auth)

4818 (IN–1331) INTEGRITY OF STAINLESS STEEL CLADDING ON EBR-II FUEL IN WATER. Zimmerman, C. A.; Rhodes,

D. W. (Idaho Nuclear Corp., Idaho Falls). Oct 1969. Contract AT(10-1)-1230. 6p. Dep. CFSTI.

The integrity of the cladding of irradiated stainless steel-clad EBR-II fuel pins was determined during and after a two-year storage period in water at the Idaho Chemical Processing Plant. No significant leakage of fission products, and therefore no significant penetration of the cladding, were observed. (auth)

4819 STRUCTURE CHANGES IN SHORT-TIME TREATMENT OF URANIUM DIOXIDE WITH AND WITHOUT NEUTRON IRRADIATION AS A HELP IN THE DETERMINATION OF THE TEMPERATURE DISTRIBUTION IN FUEL ELEMENTS FOR NUCLEAR REACTORS. Hoechel, J.; Saur, G.; Borchers, H. (Technishe Hochschule, Munich). J. Nucl. Mater. 33: 225-41(Nov. 1969). (In German).

The thermal conductivity of UO_2 was measured from room temperature up to the melting point during very short irradiation times. For the low temperature range up to 900°C thermal conductivity was measured directly. For the high temperature region, the thermal conductivity was calculated with the help of characteristic changes in the structure of the fuels with or without neutron irradiation and taking into account the melting point. The thermal transport from fuel to can was allowed for in making these calculations. A study of grain growth outside the reactor supplied no clear interpretation of the kinetic processes. All experiments were done with the same starting material. The thermal conductivity integral from room temperature to melting point, obtained in the way described, was found to be $\int \lambda(T) dT = 96$ W/cm ± 10 W/cm (maximum error). (auth)

4820 A CONTRIBUTION TO THE INTERPRETATION OF HIGH-TEMPERATURE IRRADIATION EMBRITTLEMENT. Reiff, K. H. (Siemens AG, Erlangen, Ger.). J. Nucl. Mater. 33: 129-37(Nov. 1969).

At temperatures above about 500°C neutron irradiation produces high-temperature embrittlement of austenitic steels and nickel alloys due to the forming of helium in the lattice by (n, α)-transmutation processes. It is shown how this irradiation embrittlement can be interpreted with the aid of the model of the gas-filled wedge-type crack. (auth)

4821 STABILITY OF VOIDS IN NEUTRON IRRADIATED NICKEL. Brimhall, J. L.; Mastel, B. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater. 33: 186-94(Nov. 1969).

The formation and stability of voids introduced in high purity nickel by irradiation with neutrons in the temperature range 50 to 575°C has been studied. Octahedral shaped voids formed during irradiation at temperatures $\geq$260°C (0.30 T_m). The size of the voids increased and the density decreased with increasing irradiation temperature, but the volume fraction of voids was relatively temperature independent. When nickel was irradiated at a low temperature (50°C) and subsequently annealed at an elevated temperature, stacking fault tetrahedra were formed; voids did not develop. The voids present in the nickel irradiated at temperatures >260°C coarsened during isothermal annealing at 600°C by the process of large voids growing at the expense of smaller voids. At higher annealing temperatures, the voids annealed heterogeneously and were completely annealed at 800°C. The configuration and density of voids in the nickel was compared to that in copper, aluminum, and molybdenum. (auth)

4822 EFFECTS OF LARGE FAST-NEUTRON FLUENCES ON THE STRUCTURE OF STAINLESS STEEL. Stiegler, J. O.; Bloom, E. E. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater. 33: 173-85(Nov. 1969).

Changes in microstructure which occur when type 304L stainless steel is irradiated at temperatures between 370 and 472°C and fast-neutron fluences between 0.8 and 1.4×10^{22} n/cm^2 have been investigated by electron microscopy. The fuel cladding from an Experimental Breeder Reactor-II driver fuel element served as the experimental material. Voids and dislocation loops formed by the precipitation of irradiation-produced vacancies and interstitials were observed in each specimen. As the irradiation temperature was increased the density of each type of defect decreased and the average size increased. Upon postirradiation annealing at 600°C, the dislocation loops converted to a dislocation network and the smallest voids (diameters <150 Å) began to disappear. As the annealing temperature was increased the dislocation and void densities both decreased. After annealing 1 hr at 900°C, the voids were completely removed and the dislocation density was reduced to that of an unirradiated annealed specimen. (auth)

4823 HIGH-TEMPERATURE RECOVERY OF NEUTRON-IRRADIATED RHENIUM. Vandenborre, H.; Stals, L.; Nihoul, J. (SCK-CEN, Mol, Belgium). Phys. Status Solidi; 35: 1009-15 (1 Oct 1969).

The recovery of rhenium after neutron irradiation at ≈390°K was studied up to 1130°K by means of electrical resistivity measurements at 4.2°K. Two irradiations were performed in the BR2 reactor at Mol: one up to a fluence of 7.6×10^{18} n cm^{-2} (thermal) and 4.3×10^{17} n cm^{-2} (fast, E > 1 MeV) and the other one up to a fluence of 3.2×10^{19} n cm^{-2} (thermal) and 1.8×10^{18} n cm^{-2} (fast, E > 1 MeV). The irradiation-induced resistivity is only partially recovered at 1130°K, where the annealing of defects is supposed to be complete. This effect is attributed to the transmutation of rhenium into osmium and tungsten. The annealing spectrum between 400 and 1130°K consists of several peaks, the main peak occurring at about 650°K (0.19 T_m) preceded by a subpeak at about 620°K. The latter one is more clearly resolved for the lower irradiation dose. This is also the case for the minor peaks occurring at about 490 and 540°K. Towards higher temperature, continuous recovery occurs in the temperature interval 800 to 1000°K, whereas a small annealing stage has been observed at about 0.32 T_m. The 0.19 T_m stage shows a peak shift towards lower temperatures for higher defect concentration. It is believed that this stage corresponds to stage III of the pure fcc metals. (auth)

4824 DIFFUSION OF TRITIUM IN SILVER–LITHIUM ALLOYS AFTER NEUTRON IRRADIATION. Migge, H. (Hahn-Meitner Institut, Berlin). Phys. Status Solidi; 35: 673-83(1 Oct 1969). (In German).

The release of tritium from neutron-irradiated Ag–20 at. % Li alloy is measured in the range of 280 to 600°C. Diffusion coefficients have a stronger temperature dependence below 390°C than above (activation energies 1.3 and 0.49 eV). In increasing the neutron dose from 3.6×10^{16}/cm^2 to 1.3×10^{17}/cm^2, the temperature dependence increases in both ranges (2.34 and 1.14 eV) and the diffusion coefficients decrease. An initial period of nonideal volume diffusion kinetics is observed in the whole temperature range. A time constant b [s^{-1}] for the release of the tritium atoms from traps is calculated from this initial phase. Activation energy and pre-exponential factor of b seem to be independent of the neutron dose. (auth)

4825 EFFECT OF NEUTRON IRRADIATION ON SOME THERMOPHYSICAL CHARACTERISTICS OF METALS. Pedchenko, K. S.; Karasev, V. S.; Trikula, V. M. (Kiev Inst. of Physics). Inzh.-Fiz. Zh.; 17: 665-72(Oct 1969). (In Russian).

It was shown experimentally that in metals irradiated by fast neutrons, heat capacity and thermal emf change due to radiation point and other defects of the crystal grid. Measurements by differential thermal analysis showed that the heat capacity of copper increased by 8% after irradiation to $8 \cdot 10^{17}$ fast neutrons/cm^2. These data were used for the calculation of vacancy concentration. In a pair of irradiated–unirradiated metals essential thermal emf appeared. The data obtained for Mo ($\epsilon = dE_t/dT$ = 1.3 μV/deg) are used to show: that when metals are irradiated their electronic capacity also changes; and calculation of vacancy concentrations by induced emf yields rather real values. (auth)

Ceramics and Cermets

Refer also to abstracts 4209 and 4710–4712.

Corrosion and Erosion

Refer also to abstracts 4725 and 4848.

Preparation and Fabrication

Refer also to abstracts 4716, 4727–4729, 4731, 4732, 4740, 4749, 4750, and 5573.

4826 (BNWL–1198) PARAMETRIC STUDY OF THE UO_2 PELLET COMPACTING OPERATION. Sammis, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

A $5 \times 3 \times 2$ factorial experiment was designed to examine the effects of compacting pressure, holding time at pressure, and preslugging pressure on the physical properties of UO_2 pellets formed by dry pressing. The range of forming pressure was 10,000 to 50,000 psi in 10,000 psi increments; the hold times were 0.2, 0.4, and 0.6 sec; and the preslugging pressure were 5,000 and 10,000 psi. The physical properties examined were green and sintered pellet lengths, diameters, weights, and densities, and also the firing shrinkages of length and diameter. Analyses of variance were used to determine the significance of the observed effects. Forming pressure exhibited the greatest effect on all of the dependent variables except pellet weight. The effect of forming pressure on sintered length, diameter, and density is best described by a cubic equation. Preslugging had the greatest effect on green and sintered weight. The preslugging–forming pressure interactions were significant for sintered diameters and for both green and sintered densities. Reproducibility of the pellets produced by each treatment combination was excellent. Judging from the sizes of the error terms in the analyses of variance, all other factors that could have affected the system (feed material consistency, sintering, etc.) were controlled. (auth)

4827 (ORNL–4440, pp 3-28) DEVELOPMENT OF FAST-REACTOR OXIDE FUELS. Patriarca, P.; Lotts, A. L. (Oak Ridge National Lab., Tenn.).

Pellets of 85 and 91% of theoretical density were fabricated for two capsules for transient tests of sol-gel fuel in the Transient Reactor Test Facility (TREAT). Fuel pins for the two TREAT capsules were loaded, welded, and inspected. Welding and brazing development for the assembly of the TREAT capsules was completed, and each subassembly of the capsule was prepared. Existing equipment was altered to reduce the background from the system. Data on the release of gas from microspheres at 1600°C include 0.05 cm^3/g for the coarse microspheres and 0.27 cm^3/g for the fines. Studies on plastic deformation of UO_2 were continued to determine the effect of atmosphere and temperature on the deformation of UO_2 derived by the sol-gel and ammonium diuranate (ADU) processes. Work was also continued to determine the relations between lattice parameter composition and O activity of $(U,Pu)O_2$ and to determine the effect of thermal gradients on composition. In addition, thermodynamic calculations were made to determine the distribution of fission products that results from burnup of $(U,Pu)O_2$ fuels. This was done by determining the distribution of bound O atoms after various periods of time at full power. The irradiation of two instrumented capsules that contain Sphere-Pac $(U,Pu)O_2$ continued normally in the Engineering Test Reactor (ETR). One of these, operating at a linear heat rate of about 16.5 kW/ft achieved a burnup level of about 7.5% fissions per initial metal atom (FIMA). Examination was initiated using neutron radiography and gamma scanning of one ETR capsule, which contained three Sphere-Pac $(^{238}U_{0.85},Pu_{0.15})O_2$ fuel rods and one UO_2 fuel rod and was operated at a linear heat rate of 18 kW/ft to a target burnup level of 5% FIMA. No fuel rod showed evident failure. The neutron radiographs indicated increased diameters on both ends of the fuel columns for all four rods. Since this indicates flux peaking near the low-density thoria insulators, a mathematical analysis of this effect is being conducted. The second instrumented capsule containing Sphere-Pac $(U,Pu)O_2$ fuel was continued in operation in the Oak Ridge Research Reactor (ORR). The temperature at the center of the fuel has been used to control the operation of the capsule, and to date this central temperature has been raised in steps from 100 to 1350°C. There has yet been no indication of restructuring of the fuel. The hazards analysis for the series I experiments in the transient test program was sent to Argonne National Laboratory for review, and the testing of the first two capsules is scheduled. The five encapsulated fuel rods being irradiated in the Experimental Breeder Reactor-II (EBR-II) subassembly X050 have achieved about 50% of the planned exposure 7500 MWd. The planning of a series II unencapsulated test is essentially complete. Development of methods for calculations used in irradiation testing are reported in which the PROFIL code was adapted to the situation in which fuel is removed from the reactor after restructuring has occurred and placed in a different reactor position with a different flux environment. (auth)

4828 (ORNL–4440, pp 29-55) DEVELOPMENT OF HIGH-PERFORMANCE LMFBR FUELS. Patriarca, P.; Scott, J. L. (Oak Ridge National Lab., Tenn.).

The facility for x-ray analysis of $(U,Pu)N$ pellets and powders became operational. Both diffractometer and Debye-Scherrer techniques are included. Additional information was obtained on the reaction path when UC_2 is converted to $U(C,N)$. The $U(C,N)$ was found to remain near the composition in equilibrium with UC_2 and C for the greater part of the conversion. Vanadium was found to react with UC to form V_2C and U with UO_2 to form a new phase, UVC_2. This phase is not stable in the presence of C, but can react to form UC_2 and VC. The $UV-VC-V_2C$ three-phase region may be a good buffering system for use of carbide fuels with stainless steels or Mo alloys. Both single and polycrystalline UN were irradiated unrestrained to burnups above 2 at.% heavy metal with a peak temperature above 2000°C. Markedly greater swelling was noted for polycrystalline pellets. In pins with cladding restraint, polycrystalline UN, originally 94% of theoretical density, was found to swell into a central void at a temperature of about 1200°C. (auth)

4829 (ORNL–4440, pp 192-215) DEVELOPMENT OF FUEL ELEMENT FABRICATION. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

It was demonstrated that roll crushing UAl_x powders increases the yield of a usable product. However, the very high recoveries of about 90% that were previously reported are achieved only when crushed and remelted material is used; a single cycling of the material, with five remelts, yielded a recovery of only 75 to 80%. Variation in the concentration of U between 65 and 71 wt % had no effect on yield. The volume of voids in pressed and hot-rolled Al powder compacts, similar to the High Flux Isotope Reactor (HFIR) insert, was increased by the addition of 10 to 50 wt % ZrO_2 powder. The increase was less than found with fuel additions. Examinations by optical and transmission electron microscopy of type 6061 Al samples after cyclotron injection with 0.33 ppM H followed by various anneals revealed no evidence of blisters or bubbles. Blistering was encountered in plates in which both ends of the wrought Al cores were rounded in an attempt to reduce dogboning. Up to 9% void volume was obtained with plates fabricated for the HFIR outer annulus with 50 wt % loading of burned oxide fuel. Plates for tests of high burnup of a heavily loaded core were prepared and are awaiting insertion. As with the full-size plates, the highest void contents were obtained with the burned oxide fuel. No fabrication effects could be determined that were dependent upon fuel particle size, even with 100% −325 mesh powders. Examination of a second spent HFIR fuel element was completed except for postirradiation blister-annealing tests. In general, the element was found to be in excellent condition, with no indications of potential failure or significant dimensional changes. The oxide film on the surfaces of the fuel plates in this element was significantly thinner than that found on plates from the previous element, apparently because a thin oxide film was intentionally produced on the surfaces of the plates in the earlier HFIR fuel element before they were placed into operation. Studies on the measurement of fuel inhomogeneity by radiographic densitometry were completed. (auth)

4830 STUDY OF FRITTING AND COMPRESSION AT HIGH TEMPERATURE OF THE DIBORIDES OF TITANIUM AND ZIRCONIUM WITH TRANSITION METAL ADDITIONS AND SOME PROPERTIES OF THE MIXTURES OBTAINED. Meyer, R.; Pastor, H. (Ugine-Carbone, Grenoble, France). Planseeber. Pulvermet., 17: 111-22(July 1969). (In French).

It was shown that the four metals used (Cr, Mo, W, and Re), especially at low concentration (7.5%), appreciably accelerate the fritting of the diborides TiB_2 and ZrB_2 and permit, in the case of fritting under pressure, obtaining the theoretical density. Structural analysis showed that the four metals react chemically with the diboride. These metallic additions appear to have a beneficial effect on the mechanical behavior of ZrB_2 but do not improve to a practical extent the resistance to oxidation at high temperature (1200°C, 100 hours). (tr-auth)

4831 THE EFFECT OF RHENIUM ON THE MECHANICAL PROPERTIES OF W–2 WT. PERCENT ThO_2. Sell, H. G.; Stickler, R. (Westinghouse Electric Corp., Bloomfield, N. J. Westinghouse Electric Corp., Pittsburgh). Planseeber. Pulvermet., 17: 71-102(July 1969).

Experiments to produce W-5 or 10% Re alloy ingots containing a 1 or 2% thoria dispersion by powder metallurgical techniques are described. Ingots of these alloys with the desired dispersion could be sintered but not hot worked. Ingots of a W-5 Re-2 ThO_2 alloy sintered from blended W, Re, and ThO_2 powders containing a coarse ThO_2 dispersion could be swaged successfully to rods. These rods were evaluated in regard to solid solution and dispersion strengthening, the effect of rhenium and the ThO_2 dispersion on the ductile-brittle transition temperature (DBTT), and the modes of fracture. The results are compared with those on pure W, doped W, doped W-3 Re, and W-2 ThO_2. (auth)

4832 RADIATION CONTROL COATING. (to North American Aviation, Inc.). British Patent 1,170,065. 12 Nov. 1969. Priority date 10 Sep 1965, United States.

A method is described for coating a thermally emittive surface with a composite thermal radiation control coating have a low ratio of solar absorptance to thermal emittance. The thermally emittive surface is coated with a first layer of a mixture consisting essentially of aluminum phosphate, chromium oxide, nickel oxide, and cobalt oxide. This layer is heated to form a first cured film. A second layer of a mixture consisting essentially of stannic oxide and aluminum phosphate is deposited on the first layer and heated to form a second cured film adherent to the underlying first cured film. (J.R.D.)

4833 PROCESS FOR MAKING GRAPHITIC NEUTRON ABSORBING ARTICLES. Cledat, Jean; Moreau, Michel; Rappeneau, Jean (to Commissariat a l'Energie Atomique). British Patent 1,169,322. 5 Nov 1969. Priority date 24 Mar 1967, France.

A process for preparing neutron absorbers is described.

Powdered artificial graphite is mixed with either boron nitride, borocalcite, or rare earth oxides and a carbonizable binder is added. The absorber is heated at 900 to 1700° in the absence of air. (J.R.D.)

4834 SOLID-STATE CHEMISTRY OF THE BINARY SULFIDES, SELENIDES, AND TELLURIDES OF THE RARE EARTH ELEMENTS. Flahaut, Jean; Laruelle, Pierre. Progr. Sci. Technol. Rare Earths, 3: 149-208(1968). (In French).

The methods of preparation, crystal structures, phase distribution, crystal types, and phase diagrams of the sulfides, selenides, and tellurides of the rare earth elements are reviewed. The bibliography encompasses titles from 1904 to 1967. 136 references are given. (Metals Abstr.)

4835 OBTAINING SIMPLE AND MIXED METALLIC CARBIDES. II. [PRODUCTION, STRUCTURE, AND THERMODYNAMIC PROPERTIES OF] CARBIDES OF VANADIUM, TANTALUM, AND NIOBIUM. Paris, Rene A.; Clar, Edith. Chim. Ind. (Paris), 102: 57-62(July 1969). (In French).

The carbides were prepared by reduction of V_2O_3, Ta_2O_5, and NbO_2 by means of mixtures of CH_4 and H_2. X-ray data for the structure of the produced carbides are given. All of the produced carbides were more reactive with O than carbides obtained from commercial sources. The thermodynamics of the reductions are discussed. (Metals Abstr.)

4836 FABRICATION AND CHARACTERIZATION OF METAL CARBIDE-GRAPHITE COMPOSITES. Harada, Y.; Bortz, S. A.; Blum, S. L. (Illinois Inst. of Tech., Chicago). pp 608-29 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Refractory metal carbide-graphite composites were prepared by hot pressing at 2600 to 3200°C. The effect of variations in composition and processing on flexural, tensile, and compressive strengths; thermal expansion and conductivity; high temperature deformation, and electrical resistivity were determined, both parallel and perpendicular to the hot pressing direction. The NbC-C and TaC-C systems were principally studied while other systems such as TiC-C, ZrC-C, HfC-C, VC-C, $MoC_{(1-x)}$-C and WC-C were also investigated. Excellent high temperature behavior was generally exhibited. At a carbide content of 20 vol %, flexural strengths at 2000°C of over 12,000 psi were measured in the with-grain direction. TaC-C composites displayed the highest elevated temperature strength and resistance to plastic deformation. Composites containing 80 vol % TaC displayed flexural strengths of over 20,000 psi in both grain directions up to 2500°C, superior to that for any commercial graphite or pure TaC. It was also determined that with increasing carbide content, higher strength, decreasing anisotropy, decreasing resistance to high temperature deformation and decreasing electrical resistivity occur. (auth)

4837 COMPRESSION OF UC-UN MIXED-CRYSTAL POWDERS BY HOT-PRESSING METHODS. Naoumidis, A.; Brinkmann, U.; Stoecker, H.-J. (Kernforschungsanlage, Juelich, Ger.). pp 630-48 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Mixed crystals from uranium monocarbide and nitride as fuels for Na-cooled breeder reactors have a number of advantages. Shaped bodies from these materials can be easily prepared by hot-pressing, where it must be assured that no reaction occurs between sample and graphite matrices. According to thermodynamic calculations U(C,N) under equilibrium nitrogen pressure, is stable with respect to carbon. It was established that $UC_{1-x}N_x$ mixed with $x \geq 0.4$ can be hot pressed in this manner directly up to 1900°C. Carbon-rich mixed crystals can be hot pressed only at lower temperatures without formation of a UC_2 layer by the reaction between the sample and matrix material. The density increased for all compositions of the mixed crystals in relation with the temperature. The compounds are in the plastic range at 1800°C and can be compressed at a pressure of 500 kg/cm^2 to over 90% of the x-ray density. (tr-auth)

4838 PRODUCTION OF HIGH-MELTING URANIUM-CONTAINING MIXED NITRIDE PHASES. Holleck, H.; Thuemmler, F. pp 649-51 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Four preparation methods for the production of high-melting uranium-containing mixed nitride phases are briefly characterized. These are the sintering of nitrides after cold or hot pressing, reaction sintering over U_2N_3, reaction sintering of metallic prealloys in a hydride-nitride-vacuum cycle, and arc melting under nitrogen overpressure and subsequent homogenization annealing. (tr-auth)

Properties Evaluations

Refer also to abstracts 4276, 4715, 4730, 4740, 4761, 4776, 4783, 4787, 4796, and 4797.

4839 (LA-4212-TR) THERMODYNAMIC PROPERTIES OF NONSTOICHIOMETRIC VANADIUM AND TITANIUM CARBIDES. Alekseev, V. I.; Panov, A. S.; Fiveiskii, Ye. V.; Shvartsman, L. A. Translated by Ralph McElroy for Los Alamos Scientific Lab., N. Mex.), from pp 435-47 of STI/PUB-162. 9p. Dep. CFSTI.

The dependence of carbon activity on composition and temperature in nonstoichiometric vanadium and titanium carbides was determined experimentally at 973 to 1223°K. Carbon activity was determined by the circulation method of investigating gaseous equilibria (with the carbide) in the H_2-CH_4-C system. It is found that when the at.%C/at.%Me ratio changes within the homogeneity region (Me refers to metal in this context), the carbon activity changes by more than two orders of magnitude. In vanadium carbide at 1000°K, for example, the carbon activity increases by a factor of 500 when the at.%C/at.%V ratio changes from 0.6 to 0.93. An equation was derived describing the composition-dependence of carbon activity and from analysis of the temperature dependences it was established that the change in carbon activity within the homogeneity region of the vanadium and titanium carbides was due to the effect of both enthalpy and entropy terms. From experimental data, the partial molar free energy of the carbon in the vanadium and titanium carbides was calculated and also, using the Gibbs-Duhem equation, the partial molar free energies of the vanadium and titanium. From the calculations the total free energies of the vanadium and titanium carbides were determined, which were then compared with published data for nonstoichiometric niobium, thorium, uranium, and hafnium carbides. The results and those found in the literature are discussed on the basis of statistical thermodynamics concepts. (auth)

4840 (SC-RR-69-662) TRANSIT ANALYSIS. Holland, J. R.; Northrup, C. J. M. Jr.; Stark, W. A.; Williams, D. C. (Sandia Labs., Albuquerque, N. Mex.). Oct 1969. 35p. Dep. CFSTI.

The helium release from $^{238}PuO_2$ microsphere fuel was calculated for six different heat-sources that have been proposed for the Transit Radioisotope Thermoelectric Generator (RTG). The release mechanism was assumed to be classified diffusion, with a two-term, temperature-dependent diffusion coefficient: $D = D_1 \exp(-E_1/RT) + D_2 \exp(-E_2/RT)$. The temperature history assumed was based upon contractor-supplied information. Two different methods of approach were used and the results were compared. Helium release was calculated both for the normal mission profile and for various possible aborts. Upper and lower limits for the release were also calculated. The origins and nature of the rather sizable uncertainties involved are discussed. (auth)

4841 ALPHA SCANNING OF SOLID SURFACES AND THE MEASUREMENT OF PLUTONIUM MIGRATION IN IRRADIATED CERAMIC FUELS. Butler, J. K.; Clarke, D. (Dounreay Experimental Reactor Establishment, Caithness, Scotland). J. Nucl. Mater. 33: 208-14(Nov. 1969).

A technique for measuring plutonium distribution in irradiated ceramic reactor fuels is based on direct alpha spectrometry of suitably prepared metallographic fuel specimens. The technique consists of three parts: an alpha autoradiograph, showing detailed distribution of alpha emitting materials within the specimen; an alpha energy spectrum with an alpha counter measuring the solid surface activity through a pinhole collimator, allowing differentiation between plutonium and other alpha emitters at each point in the specimen; and, a wet chemical analysis of the whole specimen to establish the gross integral amount of the species. Alpha spectrometry of infinitely thick sources is discussed. An expression for the energy spectrum of a plane homogeneous source was derived in terms of the stopping cross-section of the source material. Experimental values of stopping cross section for $(U,Pu)O_2$ were determined. (auth)

4842 CRYSTAL-CHEMICAL STUDIES OF SOME TRIVALENT METAL MOLYBDATES AND TUNGSTATES. Klevtsov,

P. V. (Institut de Chimie Minerale, Paris). Bull. Soc. Fr. Miner. Crist.; 92: 352-9(Jul-Aug 1969). (In French).

The crystal-chemical properties of trivalent metal molybdates and tungstates obtained by synthesis are compared with data in the literature. The crystals were synthesized hydrothermal or by the flux method. New polymorphic forms for already-known tungstates have been discovered. The symmetry of the crystals was studied by x-ray diffraction and optical goniometry. The thermal stability of the crystals and the nature of some new polymorphic transformations have been established. (auth)

4843 GRAPHITIZATION IN THE ANNEALING OF PURE HIGH-CARBON ALLOYS WITH ADDITIONS OF BORON AND ALUMINUM. Khudokormov, D. N.; Korolev, V. M. Liteinoe Proizvod., No. 6, 26-8(June 1969). (In Russian).

High-purity Fe–C–Si alloys were prepared, and the effect of additions of 0.1% Al or B on graphitization of the chilled structure during vacuum annealing at 980°C after heat treatment in vacuum at various temperature was examined. The number of graphite inclusions in the annealed ingots was plotted against the cooling rate and the temperature of preliminary heat treatment. With B addition a decreased rate of cooling led to an increase in the number of graphitization centers, while the opposite effect is observed with Al. This effect of B was not as clearly marked in commercial alloys. The graphitization mechanisms are discussed. (Metals Abstr.)

4844 CHARACTERISTICS OF SOME BINARY TRANSITION METAL HYDRIDES. Beavis, L. C. (Sandia Labs., Albuquerque, N. Mex.). J. Less-Common Metals, 19: 315-28(Dec. 1969).

The recent results obtained in the study of binary transition metal hydrides were reviewed. In addition to published work, previously unpublished data from the Sandia Laboratories is included. Subjects covered are the distinct and unusual properties of these hydrides, their preparation, and their kinetic, thermodynamic, and structural properties. (auth)

4845 SOLID SOLUTIONS OF CADMIUM SULFIDE–CADMIUM SELENIDE FILMS: PREPARATION AND DETERMINATION BY X-RAY FLOURESCENCE METHOD. Chan, Frank L.; Carpenter, James T. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Advan. X-Ray Anal., 12: 581-600(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Solid solutions of cadmium sulfide and cadmium selenide prepared by several methods at temperatures in excess of 1000°C in an inert atmosphere are described. The compositions of these solid solutions varied widely, ranging from pure cadmium sulfide to pure cadmium selenide. Films of solid solutions have been successfully prepared by vacuum deposition on various substrates. Conditions for the depositions have been investigated to prevent noticeable alteration of the composition of the solid solution during vacuum deposition. Films of various thicknesses have been prepared. Determination of film thicknesses has been carried out by the fluorescence method based on the elements existing in these solid solutions. Chemical analysis in which specimens were consumed has also been used primarily for the construction of calibration curves. X-ray fluorescence intensity versus film thickness is established for films of 0 to 100 wt % cadmium selenides up to 10.00 microns thick on aluminum substrates. Thickness determinations using selenium K_α and cadmium K_α spectra give accuracies of 0.200 ± 0.05 to 10.00 ± 0.40 microns depending on film thickness and composition. Correction factors are given for films on substrates other than aluminum. Procedures have been established for the determination of both composition and film thickness based on fluorescence intensity data. There is a relationship between the fluorescence intensity and appearance when deposited films are not of the same thickness. Correlation of these phenomena will be demonstrated. (auth)

4846 SOME ELECTROPHYSICAL PROPERTIES OF ALLOYS OF NIOBIUM AND TITANIUM MONOCARBIDES IN THEIR HOMOGENEITY RANGE. Samsonov, G. V.; Upadhyaya, G. S. (Inst. of Materials Science, Kiev). pp 652-62 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Results of a study of the room temperature specific electric resistance, thermo-emf, Hall coefficient, magnetic susceptibility, and the temperature dependence (50 to 1000°C) of the resistivity and thermal emf of complex niobium-titanium monocarbides in their homogeneity range are presented. The extreme values of these properties are observed at the composition $Nb_{0.5}Ti_{0.5}C_x$ which can be explained by the share of the Me^{I} to Me^{II} bond in the formation of the alloy carbide. All the alloys in the range of test temperatures show metallic conductivity with linear or nearly linear dependence of resistivity and thermal emf on temperature. On the basis of these results it is possible to infer a correlation between the properties of the complex carbide phases and the peculiarities of the formation of stable electronic configurations of the atoms of their components. (auth)

4847 STRENGTH AND PLASTICITY OF ZIRCONIUM CARBIDE. Lanin, A. G.; Fedotov, M. A.; Glagolev, V. V. pp 663-71 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

Results of an investigation concerning the changes in strength and plasticity of ZrC as affected by strain rate and temperature are presented. Attention is directed to the effects of fracture behavior as related to microstructure. (J.R.D.)

4848 REACTIONS OF HIGH-MELTING SILICIDES WITH NITROGEN AND OXYGEN. Fitzer, E.; Reinmuth, K. (Univ., Karlsruhe, Ger.). pp 767-802 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The reaction possibilities of the silicides $TiSi_2$, VSi_2, V_5Si_3, $NbSi_2$, $TaSi_2$, $MoSi_2$, Mo_5Si_3, and WSi_2 with nitrogen were discussed on the basis of available thermodynamic data and the nitration was experimentally studied. The disilicides of Mo and W are stable under pure nitrogen over 1575°C, the disilicides of Nb and Ta over 1800°C. Under these temperatures Me_5Si_3 silicides in addition to Si_3N_4 are the equilibrium phases under nitrogen. The metal nitrides are, in addition to Si_3N_4, found to be stable phases for Ti under 1800° and V, Nb, and Ta under 1550°C. All these equilibrium phases can be obtained by nitration of the disilicide with molecular nitrogen. From the experimentally determined reversible reaction temperatures between silicides, nitrides, and nitrogen, the free formation energy and entropy values were calculated for the silicides and the thermodynamic data of the high-melting silicides were supplemented. Kinetic studies were made on the oxidation behavior of the silicides $TiSi_2$, VSi_2, $TaSi_2$, WSi_2, and Mo_5Si_3, but principally on $MoSi_2$. The studies were made on addition-free sintered bodies with densities about 98%. In $MoSi_2$ a more stable structure of the oxide layer, under lower nitrogen consumption up to the retarding effect, was found than is described in the literature; also a resistance against the intergranular oxidative decomposition at about 500°C. For the kinetics of the $MoSi_2$ oxidation parabolic layer growth with an activation energy of 17 kcal/mol up to 1400°C was confirmed. The suitable measurement values were discussed comparatively with available literature data. The oxidation kinetics corresponds to that of the silicon and silicon carbide. The rate of the oxygen penetration through quartz may be the basis of conclusions concerning the transport mechanism. Over 1400°C an activation energy of 40 kcal/mol was determined for the parabolic layer growth. At high temperatures, especially over 1600°C, the parabolic growth was superposed by evaporation processes, which have a limiting effect on SiO_2 layer thicknesses. The oxidation of $MoSi_2$ in the 500°C range was compared with that of $TaSi_2$ at 1400°C. The supplementary effects of the low temperature oxidation, as the decomposition, are not material properties of $MoSi_2$, but a result of the texture. Some experiments on the effect of tensile stress on the oxidation in this temperature range were described. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 4288 and 4864.

4849 (BNWL-1177) DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS QUARTERLY REPORT, MAY–JULY 1969. Sheely, W. F. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1969. Contract AT(45-1)-1830. 72p. Dep. CFSTI.

X-ray diffraction studies and differential thermal analyses to define phase relationships and transformation temperatures in the $Pm_2O_3-Sm_2O_3$ system were completed. The phase diagram resulting from these studies shows complete, solid solubility between all of the allotropes of Pm_2O_3 and Sm_2O_3. Thermogravimetric studies on Pm_2O_3 in reducing atmospheres were completed. The results indicate deviation from stoichiometry under an oxygen potential of −100 kcal/mole O_2. The surface tension of liquid Sm_2O_3 was determined at the melting point using the pendant drop technique. The average surface tension obtained from experiments in vacuum and argon was 962 ± 53 dynes/cm. In addition, the liquid density of

Sm_2O_3 at the melting point was found to be 5.90 g/cm^3. The heat capacity of Pm_2O_3 was estimated from existing literature data on the heat capacities of other lanthanide sesquioxides. The heat capacities of cubic and monoclinic Pm_2O_3 are tabulated at 300 to 900°K and 300 to 1600°K, respectively. The vapor pressure of Pm_2O_3 was determined at 2050 to 2250°C using the Knudsen effusion technique. The vaporization process $Pm_2O_{3(s)} = 2\ PmO_{(g)} + O_{(g)}$ was assumed in analyzing the data. A second-law treatment gave $\Delta H_s = 266$ kcal for this reaction. The attenuation of radiation from a promethium metal sample by lead and aluminum shielding was measured, and the relative contributions of primary gammas and bremsstrahlung dose rate was determined. The isotopic compositions in rhodium from samples of spent fuel from the Yankee Reactor and from Hanford reactors dose rate calculations have been made for three cases of hypothetical fission product rhodium application. Completed studies on nondestructive testing techniques for $SrSiO_3$ and ^{60}Co irradiation sources have shown that high testing rates can be accomplished using ultrasonic techniques which employ multielement transducers and thermal techniques which use thermal transducers. An analytical study was completed of the moderation and detection by foil activation of neutrons from a ^{252}Cf source. The results of this analysis will be used in the design of a portable neutron source for radiography. A ^{252}Cf was obtained and an experimental camera built. The effect of target density on the cost of producing ^{238}Pu by neutron irradiation of ^{237}Np was evaluated. The variations of neutron flux and fabrication costs with target density were taken into consideration. The effect of purity on the cost of producing ^{238}Pu and the effect of increasing exposure on ^{238}Pu purity were also evaluated. The QAD code was used to calculate in-phantom dose rates for an 8.42μ ^{252}Cf needle source and to calculate neutron and photon dose rates from sources simulating a ^{238}Pu source. Considerations which must be applied in mixing isotopes to simulate a ^{238}Pu are discussed. (auth)

4850 ELECTRON MICROSCOPY INVESTIGATION OF DISLOCATIONS IN SINTERED HARD METAL CARBIDES. Persson, Gerhard (Sandvikens Jernverks AB, Sweden). Tek. Tidskr., 99: 683-4(1969). (In Swedish).

Studies of lattice defects in WC by electron microscopy is briefly described. (Sweden)

4851 CONDENSED STATE DIAGRAM OF THE BaF_2–LaF_3 SYSTEM. Zhigarnovskii, B. M.; Ippolitov, E. G. (Inst. of General and Inorganic Chemistry, Moscow). Neorg. Mater., 5: 1806(Oct. 1969). (In Russian).

The condensed state of BaF_2-LaF system was studied by DTA in the atmosphere of purified argon. A phase diagram was constructed for the system which revealed two areas of solid solutions; one with a fluoride structure with maximum of 55 mole % LaF_3 and the other with a tysonite structure with a maximum of ~15 mole % BaF_2. The melting point was found at 1482 ± 7°C, with an eutectic disintegration at 1335 ± 7°C. (R.V.J.)

4852 EFFECT OF MANGANESE, CALCIUM, AND BORON ON THE As-CAST STRUCTURE OF COMPLEX HYPEREUTECTIC COPPER–ALUMINUM ALLOY. Finardi, Jorge; Pieske, Adol; Falleiros, Ivan G. S.; Vieira, Renato Rocha. Met., ABM (Ass. Brasil. Metais), 25: 291-5(Apr. 1969). (In Portuguese).

The nominal composition of the alloy studied was 10% Al, 4% Fe, 4% N, balance Cu; specimens were cast in baked sand molds. Manganese additions of 1.0 to 3.0% had little or no effect on grain size, nor did Ca additions up to 0.1% to melts with 1% Mn. Calcium helped eliminate inclusions and provided greater hardness. Boron (also in melts with 1% Mn) was an efficient grain refiner at levels of 0.2 and 0.4%; however, at B levels over 0.1%, the fluidity of the alloy decreased. Covering the bath with graphite was helpful in obtaining a small grain size. (Metals Abstr.)

4853 OBSERVATIONS IN THIN SECTIONS OF TUNGSTEN CARBIDES. Persson, G. pp 672-5 of High Temperature Materials. Benesovsky, F. (ed.). Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1969. (In German).

From 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte/Tyrol, Austria. See CONF-680603.

The characteristics of thin sections of tungsten carbide were studied by electron microscopic and penetration radiation techniques. The results showed that real grain boundaries exist between the WC crystals. A dark field micrograph shows that the orientation variation between one crystal and its adjacent crystals is considerable. The lattice defect can exist in the WC. The compound density in sintered hard metal for these grains is about 10^8g cm^{-2}. The order of magnitude is about 10^{10} cm^{-2}. The slip plane is probably $\{10\bar{1}0\}$. The presence of slips from the $\langle 1120 \rangle$ type was verified. (J.S.R.)

Radiation Effects

Refer also to abstract 4323.

4854 (AECL–3381) IRRADIATION BEHAVIOUR OF A 500 MM LONG HOLLOW U_3Si FUEL ELEMENT IRRADIATED UNDER BLW CONDITIONS. Feraday, M. A.; Chalder, G. H.; Cotnam, K. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Reprinted Jul 1969. 19p. (EXP-NRX–61015). Dep. CFSTI (U. S. Sales Only). CAN $0.50.

A 500 mm long Zircaloy-clad element of U_3Si (4.3 wt % Si) containing a 13% central void was irradiated to an average burnup of 3600 MWd/tonne U at an average linear power output of 790 W/cm, in boiling water coolant at 55 bars pressure. A larger diameter increase (1.5%) at the midplane of the element than elsewhere was attributed to the reduced restraint imposed on the fuel in this area as a consequence of β annealing a section of the cold worked sheath. Diameter increases in the cold worked portions of the sheath (average 0.7%) were greater than in similar elements irradiated in pressurized water at 96 bars pressure; the difference is attributed to higher linear power output of the element in this test. External swelling of the element before filling of the central void was complete is attributed to the higher silicon content of the fuel compared with previous tests. No reaction between U_3Si and Zircaloy was observed at a fuel sheath interface temperature near 400°C. (auth)

4855 (CEA-R–3878) IRRADIATION OF MIXED UO_2–PuO_2 OXIDE SAMPLES FOR FAST NEUTRON REACTOR FUEL ELEMENTS. Mikailoff, Hubert; Mustelier, Jean-Pierre; Bloch, Jacqueline; Conte, Madeleine; Hayet, Lucien; Lauthier, Jean-Claude; Leclere, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1969. 73p. (In French). (EUR–4323). Dep. CFSTI (U. S. Sales Only).

Thermal flux irradiation testing of small mixed oxide pellet $(U-Pu)O_2$ fuel elements were performed in support of the fuel reference design for the Phenix fast reactor. The effects of different parameters (stoichiometry, pellet density, pellet clad gap) on the behavior of the oxide (temperature distribution, microstructural changes, fission gas release) were investigated in various irradiation conditions. The effect of fuel density decrease and power rate increase on thermal performances were determined on short term irradiations of porous fuels. (auth)

4856 (GA–9613) PREDICTION OF THE IRRADIATION PERFORMANCE OF COATED PARTICLE FUELS BY MEANS OF STRESS-ANALYSIS MODELS. Kaae, J. L.; Stevens, D. W.; Luby, C. S. (Gulf General Atomic, Inc., San Diego, Calif.). 15 Sep 1969. Contract AT(04-3)-167. 32p. Dep. CFSTI.

Three mathematical models for use in calculating the stresses and displacements in two-, three-, and four-layer pyrolytic carbon and silicon carbide coatings on microspheres of $(Th,U)C_2$ or $(Th,U)O_2$ during reactor service have been described previously. Comparisons between the results predicted by the earlier mathematical models and results of a number of irradiation tests of the three types of coatings on $(Th,U)C_2$ fuel particles are presented. The calculations have been made using data for dimensional changes of methane-deposited pyrolytic carbon under fast-neutron irradiation. Creep constants have been calculated using a relation between creep strain, stress, and fast-neutron fluence that has been found to apply to polycrystalline graphite and has been previously assumed for pyrolytic carbon. The calculation of fission-gas pressure described previously for the models has been altered to include empirical data on swelling of the fuel. A fractional release of fission gas from the $(Th,U)C_2$ fuel has been calculated from observed displacements of the outer coating on two series of two-layer coated particles during irradiation. The value obtained is consistent with the expected low diffusional release of fission gases from carbide fuel in the temperature range of the measurement. Comparisons are also made between calculated stresses and the fraction of failed coatings after irradiation testing. Appreciable coating failure occurred only in coatings with high calculated stresses, and with a few exceptions, low or zero coating failure was observed in coatings with low calculated stresses. (auth)

4857 (ORNL–4440, pp 56-8) FISSION-GAS RELEASE AND PHYSICAL PROPERTIES OF FUEL MATERIALS DURING IRRADIATION. Sisman, O. (Oak Ridge National Lab., Tenn.).

Irradiation of spheroids of $(U_{0.75},Pu_{0.25})O_2$ fuel was terminated after 4.5% heavy metal burnup. The temperature at which breakaway gas release occurred was a linear function of burnup until 3.5% burnup. Thereafter, because of a high rate of gas leakage from the specimen, the temperature at which breakaway gas release occurred did not depend primarily on further burnup. Release of fission gas, thermal diffusivity, and stored energy are being measured on a hollow cylinder of UO_2. (auth)

4858 (ORNL-4440, pp 111-13) BEHAVIOR OF REFRACTORY MATERIALS UNDER IRRADIATION. Keilholtz, G. W.; Dyslin, D. A.; Moore, R. E.; Robertson, H. E. (Oak Ridge National Lab., Tenn.).

Irradiation of the carbides of Ti, Zr, Ta, Nb, and W at 150°C and postirradiation annealing experiments completed a carbide series of experiments. The fabrication of an instrumented assembly for irradiation of depleted nitride fuels in the Engineering Test Reactor (ETR) at 1000°C is now nearly complete. This experiment is designed to evaluate the effects of He gas generated internally through the $^{14}N(n,\alpha)^{11}B$ fast-neutron reaction. Assemblies are being designed for irradiation of fast-neutron absorbers in the Experimental Breeder Reactor-II (EBR-II). Specimens of B_4C, TaC, and Ta metal will be irradiated at 400 and 750°C. (auth)

4859 (ORNL-4440, pp 114-16) FAST-NEUTRON IRRADIATION EFFECTS ON ELECTRICAL INSULATORS. Keilholtz, G. W.; Dyslin, D. A.; Moore, R. E.; Robertson, H. E. (Oak Ridge National Lab., Tenn.).

Specimens of silicon oxynitride (Si_2ON_2), a new high-temperature electrical insulator, were irradiated at about 150°C to estimated neutron fluences ranging from 0.6 to 3.6×10^{21} neutrons/cm^2 (>1 MeV). All specimens survived intact, and there was little or no release of N_2 during irradiation. Other advanced materials such as single-crystal Al_2O_3 (sapphire), high-purity single-crystal MgO, and zirconia-doped transparent polycrystalline Y_2O_3 are being fabricated for low-temperature (about 150°C) irradiations. The irradiation phase of a program on commercial alumina products is nearing completion. The high-temperature (400 to 1230°C) irradiation of a long-term Engineering Test Reactor (ETR) assembly is now complete, and the results can be compared with those previously obtained for an identical short-term assembly. The irradiation of the same alumina products at about 800°C in the Experimental Breeder Reactor-II (EBR-II) core position was started. (auth)

4860 CARBON FIBRES OF HIGH YOUNG'S MODULUS. Allen, S.; Cooper, G. A.; Nayer, R. M. (National Physical Lab., Teddington, Eng.). Nature (London); 224: 684-5(15 Nov 1969).

A study is reported on the effects of irradiation and the addition of boron on carbon fibers derived from polyacrylonitrile. Both treatments caused significant increases in Young's modulus, and in some cases increased fiber strength. Reactor irradiation to a dose of 2.2×10^{17} n/cm^2 at pile temperature was employed for the irradiation tests. Tensile strength and modulus data are tabulated. There were significant increases in strength and stiffness, but only resistivity charges. Boron was introduced into the fibers by annealing in closed crucibles made of a C–B alloy. For an annealing temperature of 2750°C the modulus increased substantially, while the resistivity decreased very substantially; the strength of the fibers was little affected. It was found that the addition of B made it possible to obtain fibers of any desired modulus at lower temperatures than normally employed. (UK)

4861 POST-IRRADIATION BeO RECOVERY ANNEALING. Klimenkov, V. I.; Khudyakov, A. V.; Sudakova, N. V.; Balandin, G. C. At. Energ. (USSR); 27: 415-18(Nov 1969). (In Russian).

The effects of annealing on microcrack behavior in irradiated BeO were investigated. BeO irradiated with an integrated fast neutron flux of 7×10^{20} cm^{-20} at 50 to 70°C ($E \geq 1$ MeV) was annealed 1050 to 1500°C. The specimen microstructure was studied. The most active sintering of irradiation induced microcracks in BeO occurred at 1400°C. Abnormally high sintering rate is accounted for by closer material packing as compared to that of the pressed powder in the original specimens as well as by the diffusion acceleration due to the presence of radiation defects in the crystals. BeO components that became worthless due to microcracking which did not lead to the integrity and form failure may be reused after the recovery annealing. (auth)

Plastics and Other Materials

Refer also to abstract 5521.

4862 (N-69-36762) AN INVESTIGATION OF THE BASIC PROPERTIES OF IRRADIATED POLYETHYLENE MEMORY MATERIALS. Keusch, Preston; Greer, Donald; Rozembersky, John (RAI Research Corp., Long Island City, N. Y.). Sept. 1969. Contract NAS1-7335. 122p. (NASA-CR-1384; RAI-397). CFSTI.

Described are the properties, work, and conclusions reached on irradiated polyethylene memory materials. The properties affecting crosslinking, the main memory factor which determines the memory in the materials were investigated using different commercial polyethylene materials. These properties include: molecular weight, molecular weight distribution, and the degree of branching. It was found that the molecular weight distribution was the main factor that influenced the crosslinking efficiency. The conditions at which crosslinking occurs- temperature, oxygen environment, and the radiation dose were investigated. Memory studies were performed on the commercial materials to see if they completely restored after being deformed. The mechanical properties of the superior memory material tested, Poly-Eth 5555 film, were also presented. Low temperature tests, tensile tests, and modulus of elasticity tests were conducted for all of the materials. It was concluded that the material with the best crosslinking properties had the best memory characteristics. (auth) (STAR)

4863 ADHESIVE BONDING. TECHNIQUES AND APPLICATIONS. Cagle, Charles V. New York, McGraw-Hill Book Company, 1968. 357p. $16.00.

Information on bonding is presented in chapters on general characteristics of adhesives, application of adhesives, criteria for joints, surface preparation, equipment, fabrication methods, testing, quality control, and specifications. A glossary of terms is included. (J.R.D.)

4864 PARTICLE SIZE EFFECTS IN RADIOISOTOPE X-RAY SPECTROMETRY. Berry, P. F.; Furuta, T.; Rhodes, J. R. (Texas Nuclear Corp., Austin). Advan. X-Ray Anal., 12: 612-32(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Theories explaining the dependence of characteristic x-ray intensity on particle size in heterogeneous materials are reviewed. Several discrepancies between the theories and between theory and experiment have been discovered. A new theory is proposed based on a more rigorous physical model. It is shown to explain well-established phenomena at least as precisely as do previous formulas. Excellent agreement was also obtained with new observations of the variation of characteristic x-ray intensity with packing degree and, in samples consisting of only one type of particle, with both packing degree and particle size. The same basic theory also predicts the observed variation of x-ray intensity backscattered from or transmitted through a sample. It was also shown that similar results are obtained with particles suspended in a homogeneous matrix, such as an aqueous slurry. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

4865 ELECTROMAGNETIC RADIATION FROM RELATIVISTIC OSCILLATORS. Wagoner, Robert V. (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 158: 739-51(Nov 1969).

The oscillatory motion of a charged particle in a linear force, field is considered in the limit of a highly relativistic maximum velocity. Expressions are derived for the flux of electromagnetic radiation per unit frequency received from such particles, and various limiting cases are considered in detail. Several distinctive features of this process are then discussed. (auth)

Cosmic Ray Exposure Ages

4866 SOLAR-TYPE XENON: A NEW ISOTOPIC COMPOSITION OF XENON IN THE PESYANOE METEORITE. Marti, Kurt (Univ. of California, San Diego, La Jolla). Science; 166: 1263-5(5 Dec 1969).

Xenon in the Pesyanoe meteorite is a mixture of several components. Solar-type xenon is a new component deficient in the neutron-rich isotopes as compared to both trapped chondritic and terrestrial atmospheric xenon. (auth)

4867 RADIONUCLIDE COMPOSITION OF THE ALLENDE METEORITE FROM NONDESTRUCTIVE GAMMA-RAY SPECTROMETRIC ANALYSIS. Rancitelli, L. A.; Perkins, R. W.; Cooper, J. A.; Kaye, J. H.; Wogman, N. A. (Battelle-Northwest, Richland, Wash.). Science; 166: 1269-72(5 Dec 1969).

The concentrations of beryllium-7, sodium-22, aluminum-26, potassium-40, scandium-46, vanadium-48, chromium-51, manganese-54, cobalt-57, cobalt-60, and thorium-232 (thallium-208) were measured in the Allende meteorite by nondestructive gamma-ray spectrometry. The high cobalt-60 content of the meteorite is indicative of a preatmospheric body with a minimum effective radius of 50 cm and a weight of 1650 kg; the aluminum-26 activity indicates a minimum exposure age of 3 million years. (auth)

Stars

4868 LIGHT OF THE SUPERNOVA OUTBURST. Morrison, P.; Sartori, L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 158: 541-70(Nov 1969).

The observed light from a supernova is primarily emitted, not from the star itself or from an exploding shell, but from a much larger volume of gas around the star, excited by ultraviolet photons from the explosion. The fluorescent intensity detected at a given observer time is described by an integral over source volume and time, which can be evaluated for simple models of the gas distribution and exciting light flash. For a δ-function flash and uniform gas density, the tail of the light curve of a Type I supernova (SN I) is quantitatively described in terms of a single parameter that measures the density. The shape of the early light curve indicates diffusion of the exciting radiation in the denser gas layers nearest the star. The SN I spectrum, including the weak continuum, the main broad bands, and their redshifts, can be explained if the emitting gas is largely ejected by the presupernova, rich in helium, and if the exciting spectrum is strong just below the He II ionization threshold and very weak above it. The cutoff at the ionization frequency is a consequence of the filtering effect of the dense inner layers. Type II events are similarly explained but are less regular, an observation suggesting that the more dilute fluorescing material seen in this type is mainly the ambient interstellar gas. From this picture, lower limits on the total energy release in supernova explosions are obtained: about 10^{52} ergs for Type I outbursts, and near 10^{50} ergs for those of Type II. The shell of ionized gas extending to many light years, which an SN I outburst must produce, may be observable as large H II regions, and is surely important in the energy balance of the galactic gas. (auth)

4869 DYNAMICAL INSTABILITIES IN SEMIDETACHED CLOSED BINARY SYSTEMS WITH POSSIBLE APPLICATIONS TO NOVAE AND NOVALIKE VARIABLES. Bath, G. T. (Univ. of Sussex, Eng.). Astrophys. J.; 158: 571-87(Nov 1969).

The stability to mass loss on a dynamical time scale of the contact component of a semidetached binary system is investigated. The possibility of such explosively rapid mass loss and its effects on initial models in various regions of the H−R diagram are studied by adiabatic perturbation of zeroth-mode disturbances. The expansion of the outer layers is found to cause instabilities which give rise to two classes of behavior. Models of class I, unstable down to the He I zone, have resulting magnitude ranges, mass-loss values, and total energy emission typical of U Gem stars. Models behaving as class II, unstable down to the He II zone, have values more typical of novae. In addition, many of the qualitative features of both observed phenomena appear to be natural consequences of the effect studied. (auth)

4870 REGIONAL VARIATIONS IN THE WAVELENGTH DEPENDENCE OF INTERSTELLAR POLARIZATION. Serkowski, K.; Robertson, John W. (Australian National Univ., Canberra). Astrophys. J.; 158: 441-7(Nov 1969).

Polarimetric observations were made in the UBV spectral regions for 38 southern stars with large interstellar polarization. The distribution on the sky of all stars with known ratio p^V/p^B of the amount of polarization in the yellow spectral region to that in the blue is discussed; for the stars more distant than 500 pc the correlation between the values of p^V/p^B vanishes for stars separated by an angular distance of about 12°. The stars for which this ratio is smaller than the median value 1.055 occur in several groups, the most prominent of them around the galactic longitudes $l^{II} = 90°$ and 270° and around the Double Cluster in Perseus. The largest values of p^V/p^B occur along the Milky Way at $l^{II} = 290°$ to 345° and in the relatively nearby associations in Ophiuchus−Upper Scorpius and in Orion. Stars nearer than 500 pc seem to have value of p^V/p^B higher than those of more distance stars. The wavelength of maximum interstellar polarization is related to the curvature of the extinction curve between 5500 and 9000 Å but does not seem to be directly related to the ratio R of total to selective extinction. (auth)

4871 REGIONAL STUDIES OF INTERSTELLAR SODIUM LINES. Hobbs, L. M. (Univ. of Chicago). Astrophys. J.; 158: 461-72(Nov 1969).

The profiles of the interstellar sodium D_2-lines are compared for stars in each of five regions of the sky with typical dimensions of 10° by 15°. The five regions lie in Perseus, the Pleiades, Orion, Scorpius, and Cygnus. Information is obtained about both the interstellar material and the stars observed. In Perseus, Orion, and Scorpius, one or more interstellar clouds are observed to have dimensions of at least 35 pc, although considerable variations in their structure often appear over a much smaller distance. Although most of the stars observed are OB stars with surrounding H II regions, the observed line widths require in most cases that the absorption occur primarily in foreground H I regions with a much higher total density. In the case of Orion, for example, the total density must increase steeply outward from the center of the Barnard Loop Nebula if the absorbers are not foreground material. Several of the strong lines observed are seen to be almost certainly circumstellar. (auth)

4872 INTERSTELLAR $L\alpha$ ABSORPTION IN β^1, δ, AND π SCORPII. Jenkins, Edward B.; Morton, Donald C.; Matilsky, Terry A. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 158: 473-8(Nov. 1969).

Equivalent-width measurements of the $L\alpha$ absorption in the rocket ultraviolet spectra of β^1, δ, and π Scorpii reveal average interstellar hydrogen densities of 3.0, 2.4, and 1.4 cm^{-3} in the line of sight to the respective stars. The column densities are somewhat greater than corresponding measurements at 21 cm, in contrast to other $L\alpha$ data in opposite directions of the sky which have given values a factor of 10 smaller than the radio results. The wide $L\alpha$ lines in the Scorpius region could result from a dense sheet of gas in front of both ζ Oph and the Scorpius stars as proposed by Herbig. On the other hand, there may be gaps in this cloud, since a lack of soft x-ray absorption for Sco XR-1 shows less than one-seventh the hydrogen column density toward nearby stars. (auth)

4873 A RADIO STUDY OF THE H II REGION ORION B. Gordon, M. A. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 158: 479-90(Nov 1969).

Observations of continuum emission of the nebula and of 94α hydrogen recombination lines (7.792871 GHz) at twenty-one points, spaced at half-beamwidth intervals (0.030°), give the distribution of mean electron temperature, emission measure, radial velocity, and dispersion of radial velocity over the nebula. The electron temperature ranges from 6000 to 8500°K, but its distribution is asymmetric with respect to the center of the radio map. The nebula appears to rotate with a period of 10^6 years about an axis running from northeast to southwest, and to expand (or contract) radially at approximately 6 km sec^{-1}. Such an expansion implies an age of 10^5 years. The exciting star must be other than ζ Ori. This nebula is compared with the Orion Nebula (NGC 1976). (auth)

4874 NEW PHOTOMETRIC DATA FOR THE OLD GALACTIC CLUSTER NGC 188: THE PRESENCE OF A GAP, CHEMICAL COMPOSITION, AND DISTANCE MODULUS. **Eggen, Olin J.; Sandage, Allan (Australian National Univ., Canberra. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 158: 669-84(Nov 1969).**

New photoelectric UBV photometry has been combined with rereduced previous photometry for the old galactic cluster NGC 188. A gap on the rising branch of the evolving main sequence has been found in a place similar, relative to the luminosity at the turnoff from the main sequence, to the gap previously found in M67. The gap in NGC 188 occurs at $4.33 \geq M_V \geq 4.53$, which is fainter than gaps found in other clusters of old to intermediate age and which cannot be explained by some of the available theoretical evolutionary tracks. The C–M diagram extends from V = 9.8 ($M_{V0} = -1.3$) to fainter than V = 19 ($M_{V0} = 7.9$). The main sequence termination point occurs near $M_V \approx +3.8$, $(B - V)_{0,c} \approx 0.62$. These values are 0.8 mag fainter and 0.08 mag redder than the termination point in M67. The two-color diagram shows the presence of a small ultraviolet excess relative to the Hyades for stars near the main sequence. Separation of the effects of reddening and blanketing gives $E(B - V) = 0.09$ mag and $\Delta(B - V)_{bl} = 0.03$ (in the sense of line weakening for main-sequence stars). A photometric modulus of $(m - M)_0 = 10.85 \pm 0.15$ is obtained by fitting the C–M diagram to the zero-age main sequence by the use of a new curve of evolutionary deviation. Comparison of NGC 188 and M67 with old subgiants of known chemical composition reaffirms previous conclusions that old disk stars whose ages are between 5×10^9 and 10^{10} years have solar abundances in the mean, but with variations of Fe/H between 0.5 and 2 times the solar value. About 85% of all old disk stars in the solar neighborhood lie within this range. The data emphasize again that the metal content of the galactic disk has been nearly fixed since the time of its formation, with no systematic trend of Fe/H with age. Photometry of three of the four known contact binaries in MGC 188 is discussed. (auth)

4875 ISOCHRONES, AGES, CURVES OF EVOLUTIONARY DEVIATION, AND THE COMPOSITE C–M DIAGRAM FOR OLD GALACTIC CLUSTERS. **Sandage, Allan; Eggen, O. J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena. Australian National Univ., Canberra). Astrophys. J.; 158: 685-98(Nov 1969).**

Isochrones in the H–R diagram are computed in the range $4.5 \geq M_{bol} \geq 2$ by using models due to Aizenman, Demarque, and Miller, and to Iben. The curves apply for chemical compositions of X = 0.67, Z = 0.03 for the first set of models, and X = 0.708, Z = 0.020 for the second. The phase of hydrogen exhaustion on the evolving main sequence, and the shallow departure from the zero-age main sequence of tracks with $M/M_\odot \gtrsim 1.3$ cause adjacent isochrones to intersect one another near $M_{bol} \simeq +3$. Observational data shown suggest that the predicted crossover effect may occur. New curves of evolutionary deviation are calculated from the isochrones. Distance moduli for M67 and NGC 188, derived with these curves, are used to assign absolute luminosities to the cluster stars. Comparison of the cluster sequences, converted to M_{bol} and log T_e, with the isochrones, with account taken of the chemical composition, gives ages of $(5.5 \pm 0.5) \times 10^9$ years for M67 and $(8-10) \times 10^9$ years for NGC 188. A composite C–M diagram for six galactic clusters shows several new features, notable of which is the funneling of all giant branches into a small region of the H–R diagram which may be defined by the Hayashi fully convective track. (auth)

4876 BLUE HORIZONTAL-BRANCH STARS OF ω CENTAURI. Newell, E. B. (Australian National Univ., Canberra); Rodgers, A. W.; Searle, Leonard. Astrophys. J.; 158: 699-709 (Nov 1969).

Photoelectric UBV photometry was obtained for twenty-six blue horizontal-branch stars in the halo globular cluster ω Centauri (NGC 5139). For twenty of these stars Hβ profiles were determined from low-dispersion image-tube spectra. Atmospheric parameters were derived on the basis of the observed colors and line widths. The results, together with those obtained in a previously published investigation of NGC 6397, were used to define relations between effective temperature and intrinsic color for blue horizontal-branch stars. For nine stars hotter than $\theta_e = 0.55$, a mean mass–luminosity ratio $\langle M/L \rangle = -2.02 \pm 0.16$ is derived. This value is in good agreement with that obtained for the blue horizontal-branch stars of NGC 6397 by Newell, Rodgers, and Searle and with the independent estimates obtained theoretically by Christy and by Iben and Faulkner. A distance modulus was estimated for ω Cen by fitting its C–M diagram to that of M92. The result, $(m - M)_{true} - 14.0 \pm 0.3$ mag, is based on a modulus of 14.5 mag for M92 and leads to a mean luminosity $\langle \log L/L_\odot \rangle = 1.71 \pm 0.12$. The estimates of $\langle M/L \rangle$ and $\langle \log L/L_\odot \rangle$ lead to a mean mass of $\langle M \rangle = 0.53 \pm 0.20\ M_\odot$. The blue horizontal-branch stars appear to occupy a wedge shaped domain in the theoretical H–R diagram. (auth)

4877 MEASUREMENTS OF CROSS-SECTIONS FOR NUCLEAR REACTIONS RELATED TO THE ANOMALOUS COMPOSITION OF 3 CENTAURI A. **Griffiths, R. J.; Harbison, S. A. (King's Coll., London). Astrophys. J.; 158: 711-18(Nov 1969).**

Measurements of the reactions $^3He(p,d)2p$, $^3He(p,pn)2p$, $^4He(p,d)^3He$, and $^4He(p,pn)^3He$ at energies of 30 and 50 MeV show that these processes are able to account for the generation of anomalous abundances of helium isotopes found in the peculiar star 3 Cen A. This supports the model involving spallation by high-energy particles as suggested by Wallerstein and by Novikov and Syunyaev. (auth)

4878 SLOWLY ROTATING RELATIVISTIC STARS. III. STATIC CRITERION FOR STABILITY. **Hartle, James B. (Massachusetts Inst. of Tech., Cambridge. Univ. of California, Santa Barbara); Thorne, Kip S. Astrophys. J.; 158: 719-26 (Nov 1969).**

A method is given for analyzing the stabilizing effect of a slow and rigid rotation on the radial pulsations of relativistic stellar models. This method is restricted to stellar models with a one-parameter equation of state, P = P(E), for which the adiabatic index is $\Gamma = (E + P)P^{-1}(dP/dE)$–e.g., white dwarfs and neutron stars. The method is also applicable to hot, isentropic stellar models. The method does not involve solving the full dynamical equations for the pulsations of the rotating star; instead, it involves constructing a family of equilibrium configurations with a specified nonrigid rotation, and then comparing the masses or binding energies of these configurations with the masses or binding energies of the uniformly rotating models. Hence, this method is the generalization to slowly rotating stars of the "static stability analysis," which is now used widely for nonrotating stellar models. (auth)

4879 MASS-RADIUS RELATION FOR COLD SPHERES OF LOW MASS. **Zapolsky, H. S. (Univ. of Maryland, College Park); Salpeter, E. E. Astrophys. J.; 158: 809-13(Nov 1969).**

The relationship between mass and radius for zero-temperature spheres is determined for each of a number of chemical elements by using a previously derived equation of state and numerical integration. The maximum radius of a cold sphere is thus found as a function of chemical composition, and a semi-empirical formula for the mass–radius curve is derived. (auth)

4880 BINARY STARS AMONG CATACLYSMIC VARIABLES. XI. PHOTOELECTRIC AND SPECTROSCOPIC OBSERVATIONS OF THE DWARF NOVA Z CAMELOPARDALIS. **Kraft, Robert P. (Univ. of California, Santa Cruz); Krzeminski, W.; Mumford, George S. Astrophys. J.; 158: 589-97(Nov 1969).**

Z Cam is representative of a small subset of dwarf novae (U Gem stars) in which quasi-periodic outbursts of light are interrupted by intervals of relative quiescence. Like the more numerous "normal" group members, it is a semidetached spectroscopic binary (G1+ sdBe) of period 6h57.5m. The red component overflows its lobe of the inner zero-velocity surface, and matter flows from L_1 to form a disk around the hot subdwarf companion. Eclipses were not detected, but periodic behavior in the light curve, similar to that found in the eclipsing binary U Gem, suggests that the orbital inclination is moderate. It is argued that the underlying blue star is a white dwarf with accretion heating as the energy source; this model is applied to U Gem stars as a group. Their lifetimes are estimated to be near 10^9 years, a value in agreement with the hypothesis that they descend from stars of the W UMa type. (auth)

4881 THE Ba II STAR ζ CYGNI. Chromey, F. R.; Faber, S. M.; Wood, A.; Danziger, I. J. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 158: 599-606(Nov 1969).

A spectral analysis at high dispersion shows that the G8 II star ζ Cygni is a Ba II star showing a relatively small enhancement in the abundance of carbon, strontium, yttrium, barium, lanthanum, and cerium. The possible evolution of such stars is briefly discussed. (auth)

4882 ATOMIC LINES IN THE CH STAR HD 209621. **Wallerstein, George (Univ. of Washington, Seattle). Astrophys. J.; 158: 607-12(Nov 1969).**

The spectrum of HD 209621 was studied by using the equivalent widths of thirty-six lines measured on 13.5 Å mm^{-1} spectrograms. The atomic lines were compared with the G9 III star ε Vir, two other CH stars, and RU Cam by curves of growth. After reduction of each comparison to a comparison with the standard star, ε Vir, it was found that the metals are deficient in HD 209621 by a factor of 20 and that the electron pressure is lower by a factor of 10. The ratio of rare earths to metals is enhanced by a factor of 8 as compared with ε Vir. The effective temperature of HD 209621 is near 4700°K, and the absolute magnitude is near 0. Despite the low metal abundance and the components of high space velocity (U, V, W = −69, −332, +176), the star does not lie on the vertical or giant branches of the globular clusters, but rather lies to the right and below these branches. The internal evolution of HD 209621 (and other CH stars) has been accounted for quite well by the models of Schwarzschild and Härm and of Sanders. They have predicted that flashes in a helium-shell source will induce mixing which, in turn, will allow the ^{12}C to react with protons, producing ^{13}C. By $^{13}C(a,n)^{16}O$ the necessary neutrons are produced to build the observed excess of heavy elements. (auth)

4883 SPECTRA OF "INFRARED STARS" FROM 2.8 TO 5.1 MICRONS. Gaustad, J. E. (Univ. of California, Berkeley); Gillett, F. C.; Knacke, R. F.; Stein, W. A. Astrophys. J.; 158: 613-18(Nov 1969).

Low-resolution spectra from 2.8 to 5.1 μ were obtained of the infrared stars NML Tau, CIT 3, CIT 6, and CIT 13. All of the spectra contain complex absorption features, but the resolution is insufficient for positive identification of the molecular bands. NML Tau and CIT 3 appear similar to the Mira variable o Ceti. CIT 6 and CIT 13, although much cooler, have spectral features similar to those of the carbon star T Cnc. (auth)

4884 OBSERVATIONS OF THE INFRARED OBJECT, VY CANIS MAJORIS. **Hyland, A. R. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Becklin, E. E.; Neugebauer, G.; Wallerstein, George. Astrophys. J.:** 158: 619-28(Nov 1969).

Infrared colors to 20 μ and optical and infrared spectra were obtained for the irregular M variable star and bright OH source, VY CMa. Spectra at all wavelengths indicate that it is a supergiant with an effective temperature of 2500 to 3000°K. Compared with supergiants of the same temperature, VY CMa exhibits a large infrared excess and is one of the brightest objects known at 20 μ. Its OH emission, near infrared spectra, and far-infrared energy distribution are similar to those of the NML Cyg source; however, it is visually 10 mag brighter. A simple dust-shell model is proposed to explain the observations of VY CMa. Reradiation of energy by the shell is found to be the predominant source of radiation for wavelengths longer than 3 μ. The evolutionary status of VY CMa and NML Cyg is discussed. (auth)

4885 EFFECTIVE TEMPERATURES OF THE O STARS. Morton, Donald C. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 158: 629-40(Nov 1969).

Effective temperatures of O-type stars imbedded in diffuse nebulae are derived from measurements of Hα and radio fluxes from the nebulae and the apparent magnitudes of the stars. Accurate model atmospheres, with ultraviolet line blanketing where appropriate, are used for the theoretical relation between effective temperature and the ratio of Lyman-continuum fluxes to visual stellar fluxes. Although there is considerable scatter in the results, an average temperature of 48000°K is found for spectral type O5, 40000°K for O6, and 35000°K for O7. The data on two nebulae with Wolf–Rayet stars suggest that type WN 4.5 has a temperature of 50000°K while type WC8 cannot be much hotter than 35000°K. New estimates of bolometric corrections are also tabulated for each spectral type. (auth)

4886 NON-LTE MODEL ATMOSPHERES. III. A COMPLETE-LINEARIZATION METHOD. Auer, Lawrence H. **(Yale Univ. Observatory, New Haven); Mihalas, Dimitri. Astrophys. J.; 158: 641-55(Nov 1969).**

A method is presented of solving transfer problems subject to constraints of radiative, hydrostatic, and statistical equilibrium, by using a complete-linearization technique. This approach departs rather markedly from the traditional methods, and yields a computational scheme that is stable and strongly convergent. The form of the equations assures that the coupling among all physical variables is fully accounted for self-consistently to first order at each stage of the calculation; convergence is global and quadratic. The constraint equations are included in a particularly transparent way, which allows easy generalization and elaboration. Sample models of pure-hydrogen atmospheres are presented; among these, one includes Hα, Hβ, and Pα self-consistently with the continua. Models that were obtained only with great effort by using earlier techniques have been recomputed with no hint of difficulty by using the method described in this paper. (auth)

4887 RELATIVISTIC STELLAR-WIND TORQUES. **Michel, F. C. (Rice Univ., Houston). Astrophys. J.; 158: 727-38(Nov 1969).**

Several authors have calculated the torque on the Sun owing to the solar wind. Those treatments are extended to encompass both special- and general-relativistic effects. A direct parallel treatment is feasible, and the major correction is, as would be expected, from the increased effective mass density of a relativistic fluid. The treatment may be extended approximately to the limit of zero mass loss, wherein the torque is entirely from the electromagnetic energy radiated by the rotating magnetic moment of the star. Application to rotational models of pulsars is illustrated with the conclusion that NP 0532, for example, would have a magnetic moment of order 3×10^{28} gauss cm^3 (within certain assumptions regarding the rate of mass loss). Centrifugal forces are capable of accelerating the plasma to ultrarelativistic velocities, even in the magnetohydrodynamic approximation. The existence of pulsars therefore suggests a new and highly efficient source of relativistic particles. (auth)

4888 ACCURACY OF K-LINE LUMINOSITIES AND THE MASSES OF RED GIANTS. **Pagel, B. E. J.; Tomkin, J. (Royal Greenwich Observatory, Herstmonceux, Eng.). Quart. J. Roy. Astron. Soc.: 10: 194-205(Sept 1969).**

Evidence is presented to show that the use of K-line luminosities gives an underestimate by about 1m for G and K class-III giants having a lower metal abundance than the Hyades. Recent estimates of masses and ages for red giants with known chemical composition are revised in the light of this result and shown to be quite consistent with other evidence. (auth) (UK)

4889 THE ABUNDANCE OF LITHIUM IN COOL STARS. II. **Warner, B. (Univ. of Texas, Austin). J. Quant. Spectrosc. Radiative Transfer.; 9: 1637-8(Dec 1969).**

Revised lithium abundances in late-type stars are given, based on the latest effective temperature scale. (auth) (UK)

4890 AN INTERESTING GEOMETRICAL PROPERTY OF VAIDYA'S ANALYTICAL SOLUTION FOR GRAVITATIONAL COLLAPSE WITH RADIATION. **Patel, R. B. (Sardar Patel Univ., Gujarat, India). Curr. Sci. (Indian), 38: 487(Oct. 20, 1969).**

It is concluded that the space–time geometry of the radiating star under gravitational collapse is conformally flat. It is pointed out that Vaidya's (1966) solution is a particular case of a general result of Krishna Rao (to be published). (W.D.M.)

4891 PROPAGATION OF SHOCK WAVES IN A POLYTROPE WITH A TOROIDAL MAGNETIC FIELD. II. SOLUTION OF COMPLETE DIFFERENTIAL EQUATIONS. **Sinha, N. K. (Monash Univ., Clayton, Australia). Aust. J. Phys.: 22: 605-12(Oct 1969).**

The differential equations for the shock parameters along shock rays in the case of propagation of a spherically developed shock wave in a polytrope with a toroidal magnetic field, obtained in Part I, were integrated numerically for a particular set of initial values. The results are compared with the corresponding results in Part I obtained by neglecting certain small terms and it is found that the effect of this omission is not significant. This substantiates the results and justifies the simplification made in Part I. (Australia)

4892 PROPAGATION OF SHOCK WAVES IN A POLYTROPE WITH A TOROIDAL MAGNETIC FIELD. I. SIMPLIFIED SOLUTION OF DIFFERENTIAL EQUATIONS. **Sinha, N. K. (Monash Univ., Clayton, Australia). Aust. J. Phys.: 22: 589-603(Oct 1969).**

The propagation of an initially spherical shock wave in a polytrope with a magnetic field was studied. The model chosen for the purpose was that of a polytrope with a toroidal magnetic field given previously by Sinha (Aust. J. Phys., 21: 283-291(1968)). Butler's Method (Proc. Roy. Soc. (London), Ser. A., 255: 232 (1960)) was extended to transform the set of governing partial differential equations into a set of ordinary differential equations involving derivatives in the direction of propagation of the shock element at any point. An approximate solution is obtained and the effect of the toroidal magnetic field on the geometry of the front as well as on the effects brought about by the shock is discussed. (Australia)

4893 RADIAL VELOCITIES OF FIELD HORIZONTAL-BRANCH STARS. I. **Philip, A. G. Davis (Dudley Observatory, Albany, N. Y. State Univ. of New York, Albany. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 158: L113-15(Nov 1969).**

Spectra were obtained for twelve of the field horizontal-branch stars found by Philip. The Z-velocity dispersion for seven NGP stars is 113 km sec^{-1}, which confirms their membership in Population II and shows that the Z-velocity dispersion increases with decreasing brightness. (auth)

4894 1 TO 4 MICRON SPECTRA OF FOUR M STARS AND ALPHA TAURI. Thompson, Rodger I. (Massachusetts Inst. of Tech., Cambridge); Schnopper, Herbert W.; Mitchell, R. I.; Johnson, H. L. Contract NSR-03-002-048. Astrophys. J.; 158: L117-22(Nov 1969).

Infrared spectra of four M stars and α Tau, obtained with a Michelson interferometer, are presented at a resolution of 9 cm^{-1}. Absorption bands of $^{12}C^{16}O$ are observed in all of these stars, but no positive identification of $^{13}C^{16}O$ bands can be made. The intensities of the $^{12}C^{16}O$ bands in the M stars and in α Tau are compared, and the possibility of nonlinear curves of growth for the $^{12}C^{16}O$ bands is discussed. The high-temperature stellar H_2O absorptions in o Cet (Mira) are again observed. (auth)

4895 POLARIZATION OF REFLECTION NEBULAE ASSOCIATED WITH VY CANIS MAJORIS AND R CORONAE AUSTRINAE. Serkowski, K. (Australian National Univ., Canberra). Astrophys. J.; 158: L107-10(Nov 1969).

Polarization of more than 40% was found in the blue spectral region for the nebula associated with the OH and H_2O emission source VY Canis Majoris and 13% for the nebula associated with R Coronae Austrinae. Colors of the nebulae are similar to those of the illuminating stars. Polarization in the blue spectral region of the T Tauri star R CrA increased during 5 weeks from 9 to 18%. (auth)

4896 BV PHOTOMETRY OF STANDARD STARS. Haeggkvist, Love; Oja, Tarmo (Astronomical Observatory, Uppsala). Ark. Astron.; 5: 303-4(1969).

During the years 1961–1967, 34 stars were used as standards for the photoelectric BV photometry at the Uppsala Observatory. Accurate values of V and B–V for these stars were derived by re-reducing all good photometric nights (altogether 105 in number) and determining the final values of the magnitudes and colors by an iterative process. The magnitudes and colors in the instrumental system were transformed to V and B–V by means of the formulas determined by Häggkvist and Oja (1966). The internal mean error of one observation of V is 0.15m, and of B–V 0.013m, and the average mean error of the final values 0.002m in V as well as in B–V. (Sweden)

4897 INVESTIGATIONS OF A MILKY WAY FIELD IN SCORPIUS. VI. RADIAL VELOCITIES OF BRIGHT O AND B STARS. Roslund, Curt (Lund Observatory, Sweden). Ark. Astron.; 5: 209-20(1969).

Radial velocities were determined from prism spectrograms with a dispersion of 90 Å/mm at Hγ for twenty-six O and B stars brighter than the ninth magnitude in a Milky Way field in Scorpius. For twenty-one of the stars no determination of radial velocity has been reported previously. (Sweden)

4898 A PHOTOELECTRIC SEQUENCE NEAR NGC 5128. Roslund, Curt (Lund Observatory, Sweden). Ark. Astron.; 5: 249-51(1969).

A magnitude sequence of twenty-four stars ranging in brightness from the seventh to the fifteenth visual magnitude has been set up photoelectrically in the UBV system less than one degree south of the peculiar galaxy NGC 5128 (Centaurus A). (Sweden)

4899 INVESTIGATIONS OF A REGION IN MONOCEROS. III. MK CLASSIFICATION OF STARS. Karlsson, Bengt (Lund Observatory, Sweden). Ark. Astron.; 5: 241-8(1969).

Spectral types on the MK system were determined from slit spectrograms (dispersion 77 Å/mm at Hγ) for 39 B, A, and F type stars in a field around NGC 2264 ($l^{II} = 203^0$, $b^{II} = +2^0$). (Sweden)

4900 PHOTOMETRIC STANDARD SEQUENCES IN NORMA $l^{II} = 320^0$ TO 340^0. Loden, L. O.; Nordstroem, Birgitta (Stockholm Observatory). Ark. Astron., 5: 231-9(1969).

Photoelectric UBV photometry of 290 stars in the Norma regions, performed at the Boyden Observatory, is given primarily in order to provide standard connection sequences for photographic photometry. (Sweden)

4901 THE OPEN CLUSTER NGC 559. Lindoff, U. (Lund Observatory, Sweden). Ark. Astron., 5: 221-9(1969).

Magnitudes on the UBV system were determined for stars in the open cluster NGC 559 from a combination of photoelectric and photographic measurements. The photoelectric observations were made with the 61-cm reflector of the Lund Observatory, while the photographic plates were taken at the Kvistaberg Observatory. The color excess is 0.45^m for NGC 559 and the distance 1300 pc. The age was estimated to be 10^9 years. (Sweden)

4902 UNIQUE EMISSION-LINE OBJECT. Cowley, Anne P.: Hiltner, W. A. (Univ. of Michigan, Ann Arbor. Univ. of Chicago. Cerro Tololo Inter-American Observatory, Arecibo, Puerto Rico). Astron. Astrophys.; 3: 372-5(Nov 1969).

Line identifications were made for the peculiar emission object CPD–56°8032. The ions primarily represented are C II, C III, O II, He I, Si III, and Si IV. The strongest features are due to C II and are seen only in emission. In contrast O II and He I show strong emissions with violet-displaced absorptions. Weak and sharp emissions of H and [O II] are observed. (auth)

4903 B, V PHOTOMETRY OF NOVA HR DELPHINI, 1967. Mollerus, B. (Univ., Munich). Astron. Astrophys.; 3: 376-7 (Nov 1969).

Photoelectric observations of the Nova Del 1967 in the B- and V-regions have been made between July 11, 1967 and October 19, 1968. (auth)

4904 GRAVITATIONAL SEPARATION OF THE ELEMENTS AND TURBULENT TRANSPORT. Schatzman, E. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 3: 331-46(Nov 1969).

The diffusion equation is solved in a particular case, taking into account the transport due to gravitational separation. The stellar model used is the following: a surface convective zone, where the concentration of test particles is uniform and below, and a radiative zone, in which the diffusion transfer takes place. When the diffusion is due only to microscopic processes, the speed of separation depends essentially on the value of the diffusion coefficient. When the convective zone is shallow (F0 stars), the diffusion coefficient is not very small and the surface of the star could experience depletion of heavy and light elements, in the star lifetime, by a large factor. When the convective zone is deep, (like in the Sun), depletion takes place very slowly. The amount of depletion which would take place in F0–F2 stars is so large that the question of a diffusion barrier is raised. Only turbulent transport can oppose gravitational separation. Shear flow produces a slow turbulence. Estimates of the turbulent diffusion coefficient are given. Stellar spin-down, or meridional circulation can produce the appropriate turbulent velocity field. Even very slowly rotating stars can build a diffusion barrier sufficient to prevent gravitational separation. Various conclusions are drawn concerning metallic line stars. It is shown that the surface chemical composition must extend deeper than the convective zone. (auth)

4905 TWO STARS OF THE LARGE MAGELLANIC CLOUD SHOWING EMISSION LINES OF Fe II AND [Fe II]. Fehrenbach, Ch.; Maurice, E.; Prevot, L. (Observatoire, Marseille. European Southern Observatory, Marseille). Astron. Astrophys.; 3: 323-6(Nov 1969). (In French).

Many multiplets of Fe II and [Fe II] are identified in the emission spectrum of two stars in the Large Magellanic Cloud (S 22 of Henize and HDE 269217). A systematic difference between the radial velocities of the iron and hydrogen emission lines can be explained by an expansion of the Fe II layer. HDE 269217 shows also the hydrogen lines in absorption from H_8 to H_{20}. The expansion of the Fe II layer is larger and the expansion of the H absorption layer even more. (auth)

4906 THE STELLAR GROUP Ba 7. Kiral, A. (Univ., Basel). Astron. Astrophys.; 3: 327-30(Nov 1969). (In German).

The stellar group Ba 7 can be regarded as a physical group with a distance of 1600 pc and a reddening of E (G–R) = 0.39 mag. These data were determined on 48-in. Palomar Schmidt plates by use of a three-color photometry in the RGU-system. (auth)

4907 THE LIGHT ELEMENTS OF AN ANONYMOUS CEPHEID AND ON ITS PROBABLE MEMBERSHIP IN THE GALACTIC CLUSTER NGC 6649. Tammann, G. A. (Univ., Basel). Astron. Astrophys.; 3: 308-15(Nov 1969). (In German).

Old and new observations are combined to derive the period (P = 5.1180d) and light-elements of the suspected cluster variable in NGC 6649. The star is found to be a cepheid with a distance modulus of $(m-M)^0 = 11.58m$ and an age of $5.0 \cdot 10^7$ years. Distance, color excess, age, and the position of the star within the cluster area, strongly suggest that it is a member of the cluster although the distance of the cluster is only approximately determined due to insufficient observations. The Appendix gives some new observations of the suspected red cluster variable No. 117 in NGC 6649. (auth)

4908 CONTRIBUTION FUNCTIONS. Ruhm, H. (Landessternwarte, Heidelberg). Astron. Astrophys.; 3: 277-80(Nov 1969).

Gussmann's criticism of Elste's contribution functions is discussed. It is shown that Gussmann's interpretation of his contribution functions should be revised. (auth)

4909 CONTINUUM ENERGY DISTRIBUTION OF O.5–G0 STARS IN TERMS OF SPECTRAL GRADIENTS. **Ardeberg, A.** (Univ. of Lund, Sweden). **Astron. Astrophys.; 3: 257-69 (Nov 1969).**

The question of absolute energy distribution of stellar continua is discussed. Available observational material is examined. The relevance of spectral gradients is studied. It is found that the continuum energy distribution from $\lambda^{-1} = 0.93$ to $\lambda^{-1} = 3.13$ can be very closely represented by spectral gradients, if a proper choice of wave-number bases is made. The influence of interstellar absorption is examined. It is found possible to reduce for this influence by means of a simple reduction formula, provided that MK classifications and color excess values are available. Using intensity values by various authors, gradients are computed and reduced to a common absolute system. The dependence of the correction terms on color on spectral type are shown to be insignificant. The intrinsic gradients are studied for each luminosity class, covering a range in spectral type from O9 to G0. A separate study is made of O5–O8 stars. Gradient versus spectral type relations are obtained. The dispersion in these relations is found to be explained almost entirely by the statistical errors in the calculated apparent gradients. Thus, the relation between spectral type and intrinsic gradient is a very close one, provided that the material is divided into luminosity classes. Marked differences are found between the various luminosity classes throughout the wave-number interval studied. Also for the O stars the dispersion of gradient values is found to be very small. (auth)

4910 A NOTE ON THE SOLUTION OF EDDINGTON'S EQUATION. Africk, Steven (Brown Univ., Providence). Astrophys. Lett. 4: 153-4(Nov 1969).

By considering the eigenfunctions of Eddington's equation to be functions of the differential moment of inertia, one can construct a set of functions which a priori satisfy the orthonormality condition on the eigenfunctions. A particular set of these functions is exhibited and used to calculate the pulsation modes for a white dwarf. (auth)

4911 AN ANALYSIS OF RADIO RECOMBINATION LINES EMITTED BY THE ORION NEBULA. Hjellming, R. M.; Churchwell, E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett. 4: 165-71(Nov 1969).

Radio recombination line data for the Orion nebula are analyzed using a simple non-LTE theory to obtain $(T_e) = 11{,}000°K$, $(N_e) = 2.2 \times 10^4\ cm^{-3}$, and $(E) = 1.8 \times 10^7\ pc\ cm^{-6}$ as parameters which predict, with reasonable accuracy, nearly all of the observed hydrogen α-, β-, γ-, and δ-line strengths. (auth)

4912 PHYSICAL CONDITIONS IN THE ORION NEBULA (NGC 1976) DERIVED FROM OBSERVATIONS OF THE EXCITED HYDROGEN RADIO LINE H56α. Sorochenko, R. L.; Berulis, J. J. (Lebedev Inst. of Physics, Moscow). Astrophys. Lett. 4: 173-8(Nov. 1969).

The excited hydrogen radio line H56α has been observed in five points over the Orion nebula (NGC 1976) with a resolution of 1.9 arc min. The population of the 57th level deviates from local thermodynamic equilibrium (LTE) and $b_{57} = 0.88 \pm 0.07$. To account for the stimulated emission in the non-LTE populations one must postulate either an increased electron density—to permit clouds of electron gas—or a greater efficiency of collisional processes. The electron temperature T_e decreases and the velocities of the internal turbulent motions increase out to the edge of the nebula. The data obtained provide much better agreement between the results of T_e measurements from the optical and radio lines. (auth)

4913 RADIATION-HYDRODYNAMIC PHENOMENA IN THE ATMOSPHERES OF LUMINOUS STARS. Hillendahl, R. W. (Univ. of California, Berkeley. Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Astrophys. Lett. 4: 179-81(Nov 1969).

A physical mechanism which can result in the generation of extended stellar atmospheres is discussed. The process involves the unloading of stellar material following the arrival of a shock wave at the edge of a star. A nongray transport type radiation-hydrodynamics code was used to obtain quantitative results for a cepheid atmosphere. The computed line profiles compare favorably with those observed for supergiants. The unloading mechanism provides an explanation for the low pressure gradients (low g) in supergiant atmospheres and illustrates the importance of hydrodynamic flow in determining the temperature and density profiles in the atmospheres of luminous stars. The additional acceleration occurring in the process provides a suggested mechanism for mass loss. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 5018.

4914 RADIO OBSERVATIONS IN THE SHORT-MICROWAVE REGION. **Foster, P. R. Quart. J. Roy. Astron. Soc.; 10: 206-22(Sept 1969).**

The radio astronomical observations that have been made in the wavelength range 30 to 1 mm are reviewed. The radio spectrum is well covered down to 6 cm but at wavelengths shorter than this coverage is poor. The difficulties were technical until recently, but sensitive detecting devices and sufficiently accurate radio telescopes have been developed. Most work has been done on the planets, but other radio sources were also examined. Spectral lines from interstellar molecules and the microwave background have also been considered. (UK)

4915 ELECTRIC FIELDS IN ROTATING, MAGNETIC, RELATIVISTIC STARS. **Occhionero, Franco** (Goddard Space Flight Center, New York); **Demianski, Marek. Phys. Rev. Lett. 23: 1128-30(Nov. 10, 1969).**

All the current models for pulsars call for very large magnetic fields in rotating neutron stars. Since general relativistic effects are important in the latter, electromagnetism too must be framed consistently (which has been overlooked so far). It is shown that in a rotating neutron star even a uniform magnetic field, static in the corotating frame, implies in the same frame the static electric field, which is crucial to the pulsar emission theories. (auth)

4916 NEW PULSAR PP 0943 AND THE MAIN CHARACTERISTICS OF ITS RADIO EMISSION. **Alekseev, Yu. I.; Vitkevich, V. V.; Zhuravlev, V. F.; Shitov, Yu. P.** (Moscow Inst. of Physics). **Dokl. Akad. Nauk SSSR; 187: 1019-21(1969).** (In Russian).

Recorded pulsations of the ratio of two close frequencies (with the frequency range of 0.8 MHz) may vary several fold from one pulse to the next; such variations were also observed following several pulses of the pulsar PP 0943. (R.V.J.)

4917 SOME MODELS FOR THE EMISSION-LINE REGION OF 3C 48. **Bahcall, John N.** (California Inst. of Tech., Pasadena. Inst. for Advanced Study, Princeton, N. J.); **Kozlovsky, Ben-Zion. Astrophys. J.; 158: 529-33(Nov 1969).**

Models for the emission-line region of 3C 48 were derived by using calculated ionization distributions. Estimates are given of the parameters that characterize the emission-line region and of the relative abundance of H, He, O, Ne, and Mg. (auth)

4918 RADIOFREQUENCY RECOMBINATION LINES FROM HEAVY ELEMENTS: CARBON. **Dupree, A. K.** (Harvard Coll. Observatory, Cambridge, Mass.). **Astrophys. J.; 158: 491-503(Nov 1969).**

The population of high levels of the carbon atom is evaluated for conditions expected in H II regions and planetary nebulae. Dielectronic recombination leads to significant departures of the population from its value in thermodynamic equilibrium. As a result, the intensities of radiofrequency transitions are considerably strengthened over equilibrium values. Such behavior is typical of complex atoms and can lead to observable spectra. The enhancement of carbon recombination lines, however, appears insufficient to explain the intensities of the observed "anomalous" recombination lines in H II regions. (auth)

4919 PULSARS. **Smith, F. Graham** (Univ. of Manchester, Eng.). **Proc. Roy. Inst. Gt. Brit.; 42: 288-94(1969).**

A discourse on this subject at the Royal Institution, London, on Nov. 15, 1969 is reproduced. (UK)

4920 GYROSYNCHROTRON EMISSION AND ABSORPTION IN A MAGNETOACTIVE PLASMA. **Ramaty, Reuven** (Goddard Space Flight Center, Greenbelt, Md.). **Astrophys. J.; 158: 753-70(Nov 1969).**

The intensity, spectrum, and polarization of gyrosynchrotron radiation from an arbitrary distribution of electrons in a magnetoactive plasma are calculated. These calculations are based on detailed theories of gyrosynchrotron emission and absorption as well as on the equations of radiation transfer in the limit of large Faraday rotation. By performing extensive numerical calculations for both isotropic and anisotropic electron distributions, the influence of reabsorption and the influence of a cold plasma on the spectrum and polarization of the radiation were investigated. Using the same formalism and calculations, the possibility of negative absorption in an anisotropic gyrosynchrotron source was also investigated. (auth)

4921 POLARIZATION OF THE CYGNUS LOOP AT 11-CENTIMETER WAVELENGTH. **Kundu, M. R.** (Univ. of Maryland, College Park). **Astrophys. J.; 158: L103-6(Nov 1969).**

Polarization of the Cygnus Loop was measured at 11-cm wavelength. Strong polarization of about 15 to 25% was detected in the optically faint southern boundary of the source. The electric part of the vectors are more or less perpendicular to the southern boundary of the source. No significant amount of polarization was detected in any other part of the source. (auth)

4922 INVESTIGATION OF THE SPECTRA AND TIME VARIATIONS OF GALACTIC WATER-VAPOR SOURCES. **Buhl, David (National Radio Astronomy Observatory, Green Bank, W. Va.).; Snyder, Lewis E.; Schwartz, Philip R.; Barrett, Alan H.** Astrophys. J.; 158: L97-102(Nov 1969).

Seven galactic water-vapor sources were observed during April and May of 1969 using the NRAO 140-foot telescope. Orion and W49 exhibited time variations on the scale of a few days, while variations in W75 (DR 21) and W3 occurred over a longer period. W3 OH and VY Canis Majoris appear to be constant over a period of several months. Linear polarization was observed in four sources, and a possible correlation between time variation and polarization is suggested by some of the data. (auth)

4923 IDENTIFICATION OF S5003 CEN WITH THE NEW INTENSE X-RAY SOURCE IN CENTAURUS. **Eggen, Olin J.; Rodgers, A. W. (Australian National Univ., Canberra).** Astrophys. J.; 158: L111-12(Nov 1969).

The light variable S5003 Cen (α = 14h56.5m, δ = −33°13 [1950]) lies very near the intense x-ray source reported by Conner, Evans, and Belian and has colors as well as spectral features similar to those of other objects identified with x-ray sources. (auth)

4924 THEORETICAL IMPLICATIONS OF THE SECOND TIME DERIVATIVE OF THE PERIOD OF THE PULSAR NP 0532. **Ferrari, Attilio; Ruffini, Remo (Princeton Univ., N. J.).** Astrophys. J.; 158: L71-5(Nov 1969).

The expected value of the second time derivative of the period of NP 0532 is given, and possible relations with existing magnetic-dipole models are outlined. The amount of gravitational radiation to be expected is estimated. (auth)

4925 SEARCH FOR RAPID FLUCTUATIONS IN LIGHT FROM THE CRAB NEBULA PULSAR. **Hegyi, D. (Goddard Inst. for Space Studies, New York); Novick, R.; Thaddeus, P.** Astrophys. J.; 158: L77-81(Nov 1969).

Observations have failed to reveal fluctuations in the light from the pulsar NP 0532 on a time scale from about 3×10^{-5} to 1×10^{-8} sec. (auth)

4926 UNIFORMLY ROTATING DISKS IN GENERAL RELATIVITY. **Bradeen, James M. (Univ. of Washington, Seattle); Wagoner, Robert V.** Astrophys. J.; 158: L65-9(Nov 1969).

General relativistic corrections to the structure of an infinitesimally thin, uniformly rotating disk were calculated. The binding energy was found to increase monotonically with redshift to a value of about 40% of the rest mass energy in the limit of infinite redshift. Other interesting properties of such configurations are discussed. (auth)

4927 OPTICAL VARIATIONS IN 3C 345. **Kinman, T. D. (Univ. of California, Santa Cruz).** Nature (London); 224: 565 (8 Nov 1969).

It was stated that on June 11, 1969, the quasar 3C 345 showed a variation of ≈0.4 blue magnitudes within the span of a few hours (Hunter and Lu, Nature 223: 1045 (1969)), but it is suggested that most of the observations of these authors afforded little or no evidence of any real variation for this object. The reality of the alleged variation depended entirely on the reliability of one observation out of eleven. The present communication describes some results in the blue obtained over the period June 6–15, 1969, using a Crossley reflector and 20 in. astrograph, and in the visual with the 12-in. refractor, at the Lick Observatory. These observations gave no evidence for a variability of more than a few hundredths of a magnitude. It is emphasized that no single photographic observation can by itself be taken as sufficient evidence for a change in brightness of an object, and it is concluded that the alleged rapid variation of 3C 345 on June 11 should be treated with reserve. (UK)

4928 ROTATIONAL PROPERTIES OF NEUTRON-STAR MODELS. **Cohen, J. M.; Cameron, A. G. W. (Goddard Space Flight Center, New York).** Nature (London); 224: 566-7(8 Nov 1969).

It has been suggested that pulsars are rotating neutron stars; also that the energy source of the Crab Nebula is the loss of rotational energy from the Crab pulsar. Since neutron stars are dense, general relativistic effects are large and cannot be neglected. If the Crab pulsar is a neutron star with mass, radius, and angular velocity respectively of the order of a solar mass, 12 km, and 30 revolutions per second, then the gravitational acceleration at the surface is of the order of 10^4 times the "centripetal" acceleration, and the square of the equatorial velocity is of the order of 10^{-4} times the speed of light squared. Such a star is slowly rotating according to the usual criteria and nonrotating models can be employed to describe the density distribution; the expressions for the angular momentum and rotational kinetic energy of a stellar model (Cohen, J. Math. Phys. 8: 1497 (1967)) are used to study the rotational properties of neutron stars, and the question is considered as to whether a rotating neutron star can store enough rotational kinetic energy to act as an energy source for the Crab Nebula. The total amount of electromagnetic energy emitted by the Crab Nebula is estimated at 7×10^{37} to 1.5×10^{38} ergs/sec; this radiation is probably predominantly synchrotron radiation arising from energetic electrons spiraling in the Crab magnetic field, and the energy input for acceleration of these electrons presumably comes from loss of rotational energy of the Crab pulsar. The Crab pulsar neutron star must have a minimum mass of $\sim 0.4\ M_{\odot}$ in order to supply 10^{38} ergs/sec to the nebula. If the models do not rotate rigidly as viewed by a distant observer, but rotate faster in their cores, the rate of loss of rotational energy could be further increased, with a corresponding reduction in the minimum mass for the Crab pulsar. (UK)

4929 FURTHER SEARCH FOR HIGH-ENERGY GAMMA RAYS FROM CP 1133. **Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.); Drever, R. W. P.** Nature (London); 224: 567-8(8 Nov 1969).

Observations in April 1968 on the pulsar CP 1133 could have been compatible with the emission of a pulsed γ-ray flux $\sim 2 \times 10^{-8}$ photons $m^{-2}\ s^{-1}$ at an energy of about 7×10^{13} eV. Other observations, however, at a similar energy gave no evidence for either a pulsed or continuous flux. In view of this conflicting evidence, the authors repeated and extended their earlier observations, using improved night-sky Cherenkov receivers. Details are given of the equipment and technique employed. The observations were made during April 1969. Scrutiny of the results gave no evidence for any significant clustering of events into pulses of any width in the range 4 to 60 ms, and no peaks greater than 3.5 standard deviations above the mean were observed; the results therefore do not support emission of high energy γ-rays from CP 1133 at the time the observations were made. An upper limit of $\lesssim 8 \times 10^{-9}$ photons $m^{-2}\ s^{-1}$ at an energy $\sim 3 \times 10^{13}$ eV was inferred. The absence of a detectable γ-ray flux or optical emission relaxes the very low limits set on the magnetic field of CP 1133 by Apparao (Nature 221: 645 (1969)). (UK)

4930 FURTHER SEARCH FOR NANOSECOND STRUCTURE IN THE LIGHT FLASHES FROM PULSAR NP 0532. **Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.); Willstrop, R. V.** Nature (London); 224: 568-9(8 Nov 1969).

Following the discovery of light pulses from NP 0532 there have been several attempts to detect fine structure in the light from this pulsar, and the present communication describes a further such attempt. The observations were made with a two-channel photometer mounted at the prime focus of the Cambridge 36-in. reflector. Arrangements were incorporated to minimize local Cherenkov radiation and absorption losses; cosmic-ray contributions were found to be negligible. Details are given of the equipment and technique employed. Among conclusions reached was that it seems unlikely that NP 0532 emits light which could be detected with existing Cherenkov light receivers. It is also concluded that if any light from NP 0532 is bunched in a single pulse of ~20 ns duration in each cycle then its time-averaged magnitude must be $m_B \geq 22$. If, however, there are $\underline{n}$ such pulses in each cycle, the limit of detection is brighter by a factor $\underline{n}^{1/2}$. (UK)

4931 INTENSITY VARIATIONS OF PSR 0833-45 AT 1,720 MHz. **Cooke, D. J. (Commonwealth Scientific and Industrial Research Organization, Sydney).** Nature (London); 224: 569 (8 Nov 1969).

Reference is made to Radhakrishnan (Nature 221: 443 (1969)) who commented on an observed remarkably constant intensity of this pulsar at 1720 and 2700 MHz; during observations made in Dec. 1968 there was apparently less than 10% variation. Observations made on July 20, 1969, however, indicated that the intensity had become extremely variable; these observations were made at the Parkes Observatory using the 210-ft telescope. The degree of intensity variation of PSR 0833-45 thus appears to change markedly with time. (UK)

4932 FLUX DENSITY VARIATION IN VRO 42 22 01 AT 1,420 MHz. **Gower, J. F. R. (Univ. of British Columbia, Vancouver).** Nature (London); 224: 569-70(8 Nov 1969).

Attention has been drawn recently to the interesting properties of this radio source and its optical counterpart BL Lac. Rapid changes in intensity of the source have been reported at 6,630 and 10,630 MHz and other frequencies. A flux density of 4.2 flux units (1 flux unit = 10^{-26}W m^{-2} Hz^{-1}) at 1,420 MHz was measured in Nov. 1968, a value well below the values 6.9 and 7.3 flux units reported in 1964. Recent continuum flux density measurements have confirmed this change in intensity at 1420 MHz and showed that in late Dec. 1968 the intensity had dropped to below 50% of the average for 1964 and 1965, but returned to about 80% of this value in a period of about three months. Published flux densities at 1420 MHz are shown graphically, together with new measurements made in 1968 and 1969 with the 25.6-m radiotelescope of the Dominion Radio Astrophysical Observatory; some results obtained with the 91-m telescope at NRAO Green Bank are also included. Continued flux density measurements at several frequencies will show whether the variability can be explained in terms of current theoretical models. (UK)

4933 PERIODIC CLUSTERING OF REDSHIFTS IN SPECTRA OF QUASI-STELLAR AND OTHER UNUSUAL OBJECTS. Cowan, C. L. (Catholic Univ. of America, Washington, D. C.). Nature (London); 224: 655-6(15 Nov 1969).

It is stated that analysis of 178 z values indicated a strongly periodic system with periods $\frac{1}{6}$ and $\frac{1}{16}$ in z (among others). (UK)

4934 SUPERFLUIDITY IN NEUTRON STARS. Baym, G.; Pethick, C.; Pines, D. (Univ. of Illinois, Urbana). Nature (London); 224: 673-4(15 Nov 1969).

It is postulated that matter in the interior of a typical neutron star is a mixture of three degenerate interacting quantum liquids comprising neutrons, protons, and electrons the latter two having a density at most a few percent of that of the neutrons. This mixture is ground on the inside by a superdense core of hadrons, muons, etc., and probably on the outside by a solid mantle, and has a density of 5×10^{13} to 10^{15} g/cm^3. Superfluid states may exist in the interior, and some general features of such states are discussed, together with their influence on the properties of the star. The electrons are unlikely to be superconducting; they constitute a weakly interacting normal system which can be treated microscopically by perturbation theory. On the other hand, strong interaction forces made neutron superfluidity and proton superconductivity strong possibilities. The effect of proton superconductivity on the magnetic properties of a neutron star is discussed, and it is concluded that the magnetic flux is rigidly tied to normal neutron star matter. It is also concluded that nucleation of superconductivity cannot be accompanied by expulsion of flux and the magnetic flux at any point does not depend on whether the matter at that point is normal or superconducting. The possible ways in which magnetic flux can penetrate superconductors is also discussed, and it is concluded that the protons constitute a type-II superconductor in the vortex state; also the critical magnetic fields between which the vortex state is thermodynamically stable are evaluated. Since the flux in the superconducting regions is frozen, superconductivity in neutron stars would be expected to have far less effect on magnetic properties than previously believed. Also, in the rotation of a neutron star the electrons must corotate with the protons independently of whether the protons are superconducting since any appreciable differential rotation would give rise to inordinately large magnetic fields. Neutron superfluidity due to S-state pairing would be expected to occur for neutron densities between 0.6 and 2×10^{14} g/cm^3. The neutron superfluid will contain an array of vortex lines parallel to the rotation axis, of sufficient number that on a microscopic scale the neutrons will appear to be rotating as a rigid body and thus have a classical moment of inertia. The density of vortices per unit area is stated to be appropriate for the Crab pulsar NP 0532. The principal energy source of a neutron star is the rotational energy of the neutrons, and the question is discussed as to how the neutrons can transfer their rotational energy to the charged particles, particularly if the neutrons are superfluid. Finally, the observed decrease in the slowing-down rate of the Vela pulsar (PSR 0833-45), following its sudden speedup, is possibly due to relaxation between the solid crust and the fluid interior. (UK)

4935 ELECTRICAL CONDUCTIVITY OF NEUTRON-STAR MATTER. Baym, G.; Pethick, C.; Pines, D. (Univ. of Illinois, Urbana). Nature (London); 224: 674-5(15 Nov 1969).

It is stated that the time for the magnetic field of a neutron star to decay by ohmic dissipation plays an important part in pulsar theory, and it is shown that the decay time for the lowest mode in a spherical star is greater than the age of the Universe and that flux decay in neutron stars is therefore negligible. The primary constituents of neutron star interiors are neutrons, protons, and electrons, the number density of the electrons and protons being typically a few percent of that of the neutrons. The more mobile carriers are the relativistic electrons, and an expression is given for the conductivity in terms of a transport relaxation time. If the protons are normal they are the most effective scatterers of electrons; electrons are little scattered by neutrons, since the only interaction is with the neutron magnetic moments. The flux decay time for a 10-km radius neutron star is found to be $\sim 10^{13}$ yr, neglecting cooling of the star. The conductivity increases as the temperature decreases, and therefore the actual flux decay time will be longer than this value. It is concluded that the theory of Ostriker and Gunn (Nature 223: 813 (1969)) for the decay of pulsar signals is untenable, due to misapplication of Canuto's calculation of the electrical conductivity, which is not valid for matter in the interior of neutron stars. It is also found that the effects of electron—neutron collisions are negligible. It is mentioned that for magnetic fields B $\sim 10^{12}$ G, expected in neutron stars, the collision frequency is much less than the Larmor frequency, and that flux decay times are not appreciably affected by the high fields. The discussion assumes that the protons form a normal quantum liquid. If the protons are superconducting, the superconductivity will nucleate, and the flux can then be expelled from a superconducting region only by vortex migration to the boundaries of the superconducting regions, and the characteristic decay time for this process will be considerably higher (see Nature 224: 673-4 (Nov. 15, 1969)). (UK)

4936 INTERSTELLAR ELECTRON TEMPERATURES FROM PULSE DELAY MEASUREMENTS AND HYDROGEN LINE SPECTRA. Rohlfs, K.; Mebold, U.; Grewing, M. (Max-Planck-Institut fuer Radioastronomie, Bonn. Institut fuer Astrophysik, Bonn). Astron. Astrophys.; 3: 347-53(Nov 1969).

Measurements of pulse delay can now provide direct information on DM = $\int n_e ds$ for selected directions. By comparing DM with the observed total hydrogen density in the same area, lower limits for the ionization ratio of the hot gas component can be obtained. This gives an estimate for the temperature of the gas from an ionization theory. For high-latitude objects, temperatures of more than 10^4 °K were found, while low-latitude objects gave values of a few 10^3 °K. It is not clear, however, whether this difference is genuine or only an apparent one produced by the more complicated situation at low latitudes. (auth)

4937 ON THE FLUCTUATIONS OF ELECTRON TEMPERATURE IN H II REGIONS. Louise, R.; Monnet, G. (CNRS, Marseille). Astron. Astrophys.; 3: 270-1(Nov 1969). (In French).

The difference between optical and radio astronomical results about the electron temperatures in H II regions may be explained by electron temperature fluctuations along the line of sight as Peimbert (1968) had suggested or by the departure from thermodynamic equilibrium as studied by Goldberg (1966). The electron temperature fluctuations influence on the profile-line method (Courtès et al., 1968; Louise and Monnet, 1969) is studied. The Orion Nebula case is discussed. It is shown that the discrepancies between various methods is in qualitative agreement with the effect of both temperature fluctuations and departure from L.T.E. for radio frequency lines. (auth)

4938 INTENSITIES OF RADIO RECOMBINATION LINES. II. Andrews, M. H.; Hjellming, R. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett. 4: 159-64(Nov 1969).

Strengths of hydrogen α-, β-, γ-, δ-, and ϵ-radio recombination lines emitted by H II regions are calculated for $40 \leq n \leq 225$, T_e = 7500, 10,000, and 12,500°K, E = 10^4 to 10^8 pc cm^{-6}, and $N_e = 10^{4.5}$, $10^{5.0}$, $10^{5.5}$ cm^{-3} for α- and β-lines and $N_e = 10^2$, 10^3, 10^4, 10^5 cm^{-3} for γ-, δ-, and ϵ-lines. (auth)

4939 INTERSTELLAR SCINTILLATIONS OF PULSAR RADIATION. Lang, Kenneth R. (Arecibo Ionospheric Observatory, Puerto Rico). Science; 166: 1401-3(12 Dec 1969).

Time fluctuations in the intensity of pulsed radiation from CP 0834, CP 1133, AP 1237, and CP 1919 were investigated. Power spectra, modulation indices, frequency distributions, and decorrelation frequencies are consistent with scintillation theory. If it is assumed that these scintillations are due to irregularities in the interstellar medium that travel at a velocity of 20 km/sec, the irregularities have a scale size on the order of 10^4 km and a distance from the Earth of approximately 70 parsecs. These interstellar scintillations would not have been observed if the apparent angular diameters of the pulsars were larger than 0.3×10^{-5} second of arc, and they would cause even a point radio source to have an apparent angular diameter of approximately 10^{-3} second of arc at 318 MHz. (auth)

4940 ON THE ABSORPTION SPECTRUM OF PKS 0237-23. Grueff, G. (Istituto di Fisica, Bologna). Astrophys. Lett. 4: 141-2(Nov 1969).

Eleven absorption lines measured in various spectrograms of the quasi-stellar source PKS 0237-23 by various authors are identified with sulfur lines redshifted to z = 2.4516. (auth)

Solar Phenomena

Refer also to abstracts 5009, 5016, 5035, 5055, and 5060.

4941 (AD-692393) THE PROPOSED HELIOGRAPHIC LATITUDE DEPENDENCE OF THE DOMINANT POLARITY OF THE INTERPLANETARY MAGNETIC FIELD. Report No. Series-10-Issue-32. Wilcox, John M. (California Univ., Berkeley. Space Sciences Lab.). June 23, 1969. Contract Nonr-3656(26). 21p. CFSTI.

Rosenberg and Coleman have proposed that the dominant polarity of the interplanetary magnetic field observed near the Earth is related to the heliographic latitude of the Earth and to the polarity of the Sun's polar magnetic fields. In some cases the pattern of the observed photospheric field at equatorial latitudes can furnish an alternate explanation for the dominant polarity effect. During several consecutive solar rotations the observed photospheric field is predominantly outward at most latitudes and longitudes, and the interplanetary field polarity observed near the ecliptic is predominantly away from the Sun. A test of the proposed effect using simultaneous observations of spacecraft widely separated in heliographic longitude is discussed. (auth) (USGRDR)

4942 (N-69-33282) FIELD AND PLASMA IN THE LUNAR WAKE. Whang, Y. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1969. 29p. (NASA-TM-X-63624; X-616-69-318). CFSTI.

A theory is presented to explain the observed variations of the magnetic field and plasma in the vicinity of the Moon. Under the guiding-center approximation, solutions for the plasma flow near the Moon are obtained from the kinetic equation. The creation of a plasma cavity in the core region of the lunar optical shadow disturbs the interplanetary magnetic field. Maxwell's equations are used to study perturbations of the magnetic field in the lunar wake. The acceleration drift current, which was omitted from the earlier work, is included in the present theory in the calculation of the total electric current in the lunar wake. When the interplanetary magnetic field lines penetrate into the lunar body, due to sudden change of magnetic permeability the magnetic field is disturbed at the lunar limbs. Propagations of this disturbance with magnetoacoustic speed form a Mach cone downstream. Perturbations of the magnetic field are restricted to the region inside the Mach cone; the region outside remains undisturbed. The numerical results agree extremely well with experimental data from the Explorer 35 spacecraft. (auth) (STAR)

4943 (N-69-36434) EARLY DETECTION OF A SOLAR FLARE: A STUDY OF X-RAY, EXTREME ULTRAVIOLET, H-ALPHA, AND SOLAR RADIOEMISSION FROM SOLAR FLARES. Donnelly, R. F. (Space Disturbances Lab., Boulder, Colo.). Jul 1968. 47p. (NASA-CR-105729; ERL-81-SDL-2). CFSTI.

Solar x-ray, extreme ultraviolet, $H\alpha$, and radio emission were studied to determine what solar radiation is best suited for an automatic flare alarm system aboard a satellite for the detection of the start of a solar flare. Although hard x rays ($\lambda \ll 1$ Å), centimeter-wavelength solar radio bursts, and flashes at certain euv wavelengths usually have faster rise times and peak earlier than soft x rays in the 2- to 16-Å range, the data available to date show that, on the average, the start time of the 2- to 16-Å x rays occurs earlier than the start times for these other types of data. The early start times and large percentage increase of 2- to 16-Å x rays make this radiation the best suited for the automatic detection of solar flares. (auth) (STAR)

4944 ABUNDANCE OF IRON IN THE SOLAR PHOTOSPHERE. Rogerson, John B. Jr. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 158: 797-802(Nov 1969).

An infrared supermultiplet of lines of neutral iron was used for an abundance study of the Sun, since their formation deep in the photosphere and their high level of excitation should make them less subject to deviations from local thermodynamic equilibrium. The resulting abundance was log A(Fe) = 6.85 on a scale where log A(H) = 12.00. No evidence was found that non-LTE effects may explain the difference between photospheric and coronal abundance determinations. A mean microturbulent velocity of 3.4 km $\sec^{-1}$ is required to explain all the equivalent-width data. (auth)

4945 SELECTIVE EXCITATION IN THE FLARE OF AUGUST 7, 1958. Cowley, Charles (Univ. of Michigan, Ann Arbor); Marlborough, J. M. Astrophys. J.; 158: 803-7(Nov 1969).

The Fe I line λ4063 is enhanced in a region of the flare of August 7, 1958. The enhancement is interpreted as a selective-excitation effect similar to that observed in late-type dwarf stars. The appearance of this selective excitation is used to obtain information on the temperature and electron density in the region of the flare where the line arises. (auth)

4946 MICROWAVE PULSE TRAINS OBSERVED BEFORE AND DURING A SOLAR FLARE. Janssens, T. J. (Aerospace Corp., El Segundo, Calif.); White III, K. P. Astrophys. J.; 158: L127-8(Nov 1969).

A study of high-gain solar-radio traces taken during a 2B flare of August 8, 1968 reveals that the 16-sec-period pulse train occurring during the flash phase of the flare persisted twice as long as that previously detected in x-ray and microwave emissions and reported by Parks and Winckler (1969). Furthermore, another pulse train, with a 23-sec period, which occurred 15 min before the flare, was observed. (auth)

4947 SPECTRUM AND POLARIZATION OF SOLAR RADIO BURSTS ON A 10-MILLISECOND TIME SCALE. Warwick, James W.; Dulk, George A. (Univ. of Colorado, Boulder). Astrophys. J.; 158: L123-5(Nov 1969).

High time and spectral-resolution polarimeter observations between 24 and 37 MHz show many solar bursts with complex fine structure. Some Type III bursts resolve into intermediate-drift, narrow-band, unpolarized, circularly or linearly polarized subbursts; others appear to be unstructured, with little or moderate polarization. The few Type II and Type IV bursts thus far recorded are unpolarized. Circularly polarized Type I bursts and reverse-drift pairs appear occasionally during decametric continuum events; concurrent Type III's are structured. It is inferred then that the corona has much fine structure, with numerous plasma and hydromagnetic waves as well as shocks, and particle streams. (auth)

4948 TYPE-III SOLAR BURSTS RECORDED BY ELEKTRON-4 SATELLITE. Benediktov, E. A.; Getmantsev, G. G.; Mityakov, N. A.; Rapoport, V. O.; Tarasov, A. F. Kosm. Issled., 6: 950-1 (Nov.-Dec. 1968). (In Russian).

Cosmic radiation intensity at 1.1 and 2.3 MHz was measured by instruments installed on the satellite Elektron-4. In particular, during Aug. 3, 1964, at 00 hr 0.8 min and Aug. 21, 1964, at 0.1 hr 47 min (Moscow time) at 2.3 MHz, a third type of burst was observed which was correlated with the burst recorded by a spectrograph of range 12 to 41 MHz. The constructed curves show that the burst had a sudden start and a smooth drop of duration 2 min. The maximum burst intensity was equal to 2.2×10^{-20} $W/m^2 \cdot Hz$ at frequencies of 1.1 MHz and 7.5×10^{-20} $W/m^2 \cdot Hz$ at 2.3 MHz. The second burst intensities were 0.78×10^{-20} and 2.0×10^{-20} $W/m^2 \cdot Hz$, respectively. Dynamic spectra of both bursts are given in graphic form. (R.V.J.)

4949 NEW TYPE OF CORONAL JET ASSOCIATED WITH CHROMOSPHERIC ERUPTIONS AND "CORONAL BULBS". Burnichon, Marie-Louise; Koutchmy, Serge; Laffineur, Marius (CNRS, Paris). Compt. Rend., Ser. B, 269: 139-41(July 21, 1969). (In French).

For the first time in the history of the solar corona and owing to a convergence of very favorable circumstances, the appearance of a coronal jet resulting from a chromospheric eruption could be recorded photographically in the course of a total eclipse of the Sun. This observation is confirmed by visual data. (tr-auth)

4950 SUPERIOR CONJUNCTION OF PIONEER 6. Goldstein, R. M. (California Inst. of Tech., Pasadena). Science, 166: 598-601(Oct. 1969).

Spectrograms of the radio signals from Pioneer 6 were taken as the spacecraft was occulted by the Sun. The spectral bandwidths increased slowly at first, then very rapidly at 1° from the Sun. In addition, six solar "events" produced marked increases of bandwidth lasting for several hours. The received signal power seemed unaffected by the solar corona. (auth)

4951 PIONEER 6: MEASUREMENT OF TRANSIENT FARADAY ROTATION PHENOMENA OBSERVED DURING SOLAR OCCULTATION. Levy, G. S. (California Inst. of Tech., Pasadena); Sato, T.; Seidel, B. L.; Stelzried, C. T.; Ohlson, J. E.; Rusch, W. V. T. Science, 166: 596-8(Oct. 1969).

Pioneer 6, which was launched into orbit around the Sun on December 16, 1965, was occulted by the Sun in the last half of November 1968. During the period in which the spacecraft was occulted by the solar corona, the S-band telemetry carrier underwent Faraday rotation as a result of this anisotropic plasma. The NASA-Jet Propulsion Laboratory 210-foot (64-meter) antenna of the Deep Space Network at Barstow, California, which was equipped with an automatic polarization tracking system, was used to measure this effect. Three large-scale transient phenomena were observed. The measurement of these phenomena indicated that Faraday rotation on the order of 40° occurred. The duration of each phenomenon was approximately 2 hours. These phenomena appear to be correlated with observations of solar radio bursts with wavelengths in the decametric region. (auth)

4952 ON THE MAGNETIC SPLITTING OF MOLECULAR LINES IN SUNSPOT SPECTRA. **Woehl, H. (Univ., Goettingen, Ger.). Astron. Astrophys.; 3: 378-9(Nov 1969).**

In sunspot spectra, MgH lines show Zeeman splitting which can be used for magnetic field measurements. (auth)

4953 ANTIMATTER PENETRATION INTO SOLAR SYSTEM AND EARTH ATMOSPHERE. **Bronshten, V. A.; Stanyukovich, K. P. Kosm. Issled., 7: 597-601(July-Aug. 1969). (In Russian).**

Antimatter motion in the solar system and in the Earth's atmosphere was studied. It was found that during collisions between antimatter and interplanetary gas, in addition to antimatter annihilation, an intensive evaporation of antimatter took place, with specific energy lower than the specific energy of annihilation by an order of 10. Thus, with the density of the interplanetary gas of 1 atom/cm^3, the antimatter with radius of $r \leq 1$ cm would be able to cross over the solar system one time. While entering the Earth's atmosphere, a strong slowing down of the antimatter should take place at the expense of emission pulses appearing during the annihilation, and the antimatter intensive evaporation would reach completion for meteor size at 450- to 800-km elevation, and for $r_0 = 1$ m at 200 km. (tr-auth)

4954 OBSERVATION OF HYDROGEN FLUORIDE IN SUNSPOTS AND THE DETERMINATION OF THE SOLAR FLUORINE ABUNDANCE. Hall, Donald N. B. (Harvard Coll. Observatory, Cambridge, Mass. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. Lett. 4: 143-8(Nov 1969).

Observations of the spectrum of sunspots in the near infrared have revealed the presence of lines of the fundamental vibration-rotation band of the molecule HF. The excellent agreement between observed and laboratory wavelengths, as well as agreement between the observed and the predicted variation in equivalent width for spots of different temperatures, make the identification secure. Model calculations carried out for two spots differing in temperature by 400°K yield a solar fluorine abundance log $A_F = 4.56 \pm 0.33$, on a scale where log $A_H = 12.00$. (auth)

4955 THE ACCELERATION OF THE SOLAR WIND AND THE HEATING OF THE CORONAL PLASMA ABOVE ACTIVE REGIONS. **Bisnovaty-Kogan, G. S. (Inst. of Applied Mathematics, Moscow). Astrophys. Lett. 4: 149-52(Nov 1969).**

Analysis of the spectra of strong radio echoes from the Sun reveals a rapid rise in the velocity of the coronal plasma above plage regions. This velocity sometimes reaches 120 km/sec at a height of only $1.7R_{\odot}$. In the framework of the new ideas on the formation of the reflected signals, these data provide observational grounds for the development of a theory of the solar wind based on the results of the radar explorations of the Sun. On the assumption that the acceleration of the subsonic flow is determined by the heating caused by the dissipation of plasma turbulence, the rise of temperature and the input of energy in the region of the acceleration were computed. (auth)

4956 CONFINEMENT OF SOLAR FLARE COSMIC RAYS TO SECTORS OF THE COROTATING SOLAR MAGNETIC FIELD. **Feit, Julius (Queensborough Community Coll., Bayside, N. Y.). J. Geophys. Res.; 74: 5579-89(1 Nov 1969).**

A method is presented for solving the problem of confining solar-flare particles to definite sectors of the solar magnetic field by the use of Laplace transform coordinates. An analysis of solar events dating back to 1956 indicates that the radial diffusion coefficient $D_r = M_r r^{\beta}$ is applicable in all cases for a value of $\beta \simeq 1$. A lateral diffusion coefficient $D_\theta = M_\theta r^{\alpha}$ is postulated for the interplanetary medium with $\alpha = 1, 2$. It is shown that the ratio of M_θ / M_r must be of the order of 0.01 or less for both power laws in order to confine the particles to an initial ejection angle θ_0. The concept of a solar flare, initially confined to a small ejection angle, developing into a large-scale flare later in the event is found to be untenable. The theoretical equations predict that large-scale flares must originate with large ejection angles. The maximum value of the ejection angle is estimated to be about 90° The theoretical equations predict that the graph of log $(nt^{3/(2-\beta)})$ versus 1/t yields a straight line similar to the simple isotropic model, and this is confirmed by the experimental evidence. The theory further predicts the existence of sharp flare boundaries that have been experimentally detected for very low energy flares. It is shown that failure to adopt a suitable boundary condition at the Sun in the mathematical solution leads to erroneous results. (auth)

4957 HELIOGRAPHIC LATITUDE DEPENDENCE OF THE DOMINANT POLARITY OF THE INTERPLANETARY MAGNETIC FIELD. **Rosenberg, Ronald L.; Coleman, Paul J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res.; 74: 5611-22 (1 Nov 1969).**

Measurements of the interplanetary magnetic field taken with the Mariners 2, 4, and 5, and OGO 5 cover several parts of the interval from September 1962 to the present and several paths through the region between 0.7 and 1.5 AU and between ±7.3° in solar equatorial latitude. From an analysis of these measurements evidence is found for a distinct dominant polarity effect in the magnetic field. Specifically, the dominant polarity of the field was inward (toward the Sun) at heliographic latitudes above the solar equatorial plane and outward (away from the Sun) at latitudes below this plane. Magnetographs of the polar regions of the Sun indicate that the dipolar component of the Sun's field has been inward over the northern hemisphere and outward over the southern hemisphere since the last maximum in solar activity, which occurred in 1958. Results suggest that over most of a solar cycle, the dominant polarity of the interplanetary field in either the northern or southern hemisphere of interplanetary space is just that of the dipolar component of the Sun's field in the same hemisphere. (auth)

4958 LENGTH OF NEUTRAL LINES AS AN INDICATOR OF FLARE PRODUCTIVITY. **de Peralta, Maria Theresa C.; Billings, Donald E. (Univ. of Colorado, Boulder). J. Geophys. Res.; 74: 5822-3(1 Nov 1969).**

Giovanelli (1939) pointed out that flares are most frequent in magnetically complex sunspot groups. Severny (1964a) stated that flares tend to occur along the demarcation line between opposite polarities in the magnetic field. The total length of the neutral line between longitudinal fields of opposite sign in an active region was chosen as a parameter to incorporate these two ideas, and this parameter is compared with the flare productivity of the region. (W.D.M.)

4959 NONTHERMAL HEATING IN QUIET SOLAR WIND. **Hundhausen, A. J. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 74: 5810-13(1 Nov 1969).**

Several important parameters characteristic of the quiet solar wind are listed along with the values of the same parameters predicted by the one-fluid and two-fluid models. Comparison of the observed and predicted values has led to the hypothesis of a nonthermal heating mechanism in the solar wind. This hypothesis is discussed. (W.D.M.)

4960 INTERPLANETARY MAGNETIC FIELD DURING THE RISING PART OF THE SOLAR CYCLE. **Hirshberg, J. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res.; 74: 5814-18(1 Nov 1969).**

This letter compares the interplanetary magnetic field observed during the rising part of the solar cycle with that observed during solar minimum. The 3-hr average magnetic fields measured by the Ames magnetometer on board Explorer 33 during Nov. 1966 through Feb. 1967 are compared with the earlier results from the same months of 1963-1964. (W.D.M.)

Galaxies

Refer also to abstract 4936.

4961 (AD-691913) ANALYSIS OF IONOSPHERIC DRIFTS OBSERVED AT DIFFERENT LATITUDES. **Final Scientific Report, April 1, 1966-February 28, 1969. Harnischmacher, Ewald; Rawer, Karl (Ionosphaeren-Institut, Breisach (West Germany)). May 31, 1969. Contract AF61(052)-944. 173p. (IIB-21; AFCRL-69-265). CFSTI.**

Drift observations by the Krautkramer method from Dapango (Togo), Mayaguez (Puerto Rico) and Freiburg (Germany) are analyzed and compared after reduction to quarterly statistics. Near the magnetic equator the drift shows continuous changes of the direction so that it is not entirely zonal. At low temperature latitude the solar diurnal component is the most important one; absolute speed values are considerable smaller than at higher-temperate latitude. The predominant rotational sense of the semidiurnal components is always right hand at higher latitude but becomes left handed at lower temperate latitude in summer and fall. (auth) (USGRDR)

4962 ABSORPTION AND EMISSION OF LIGHT BY INTERSTELLAR GRAINS. **Purcell, E. M. (Harvard Univ., Cambridge, Mass.). Astrophys. J.; 158: 433-40(Nov 1969).**

The Kramers-Kronig relations are applied to the interstellar medium, which for this purpose is considered to be a vacuum sparsely populated by spheroidal grains. An integral over the spectrum of the observed extinction is thereby related to the static dielectric constant of the medium. This yields at once a lower bound on the fraction of the volume occupied by the grains. The same method is used to discuss the far-infrared emissivity of grains. The low-frequency emissivity of a grain cannot be arbitrarily increased by the inclusion of low-frequency oscillators. An upper bound on the attainable emissivity is derived, and from it a lower bound is derived on the equilibrium temperature of grains of a given size and shape. (auth)

4963 LUMINOSITY FUNCTION AND COLOR-MAGNITUDE DIAGRAM OF GALAXIES IN A CENTRAL ZONE OF THE COMA CLUSTER. **Rood, Herbert J. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 158: 657-67(Nov 1969).**

New photovisual magnitudes for 315 galaxies in a central region (0.32 sq. deg.) of the Coma cluster are presented. These data are combined with magnitudes and colors from several sources to construct luminosity functions and color-magnitude diagrams. Data for the Coma and Virgo clusters and for elliptical, S0, and SB0 galaxies are compared. Evidence is discussed which indicates that, in the Coma core, concentration toward the cluster center tends to increase with increasing luminosity. This may be a consequence of partial dynamical relaxation. There exists a tendency for the fainter galaxies to have smaller color indices. This is interpreted in terms of a possible correlation of metal abundance with galaxy luminosity. (auth)

4964 MODELS OF PARTIALLY RELAXED STELLAR DISKS. **Shu, Frank H. (Univ. of New York, Stony Brook). Astrophys. J.; 158: 505-18(Nov 1969).**

The proposal by Lynden-Bell that violently changing gravitational fields serve as the primary mechanism of relaxation in a galaxy of stars is reexamined for disk galaxies. The point of view adopted is that the only relaxation mechanism operative for stars in the early life of such galaxies is an axisymmetric form of the Jeans instability discussed by Toomre. The most probable form of the distribution function which results for a disk of infinitesimal thickness is obtained from statistical considerations. An asymptotic method of solution based on this distribution is developed for the construction of galactic models from observed rotation curves. The distribution of stars with low peculiar velocities follows Schwarzschild's law whereas that of stars with high velocities shows the asymmetry in galactic longitude discussed by Oort. (auth)

4965 NUMERICAL TEST OF THE RELAXATION TIME. **Standish, E. Myles Jr.; Aksnes, Kaare (Yale Univ. Observatory, New Haven). Astrophys. J.; 158: 519-27(Nov 1969).**

The relaxation time of a simplified model of a stellar cluster is derived analytically and compared with many numerical examples, using up to 2500 field stars. The derivation closely resembles that of Chandrasekhar; it assumes independent binary encounters and, for the purpose of comparison, introduces a cutoff limit. Close agreement is found between the numerical and the theoretical values. (auth)

4966 MOLECULAR AND SOLID HYDROGEN IN DENSE INTERSTELLAR CLOUDS. **Solomon, P. M. (Columbia Univ., New York. Inst. of Theoretical Astronomy, Cambridge, Eng.); Wickramasinghe, N. C. Astrophys. J.; 158: 449-60(Nov 1969).**

Recent observational data point to a significant underabundance of neutral atomic hydrogen in dark interstellar clouds— suggesting extensive formation of molecular or solid hydrogen. Conditions for the formation of molecular hydrogen (gaseous and solid) at grain surfaces are discussed. Grain temperatures less than ~6.5°K appear to be required for the formation of molecular H_2 and ~4°K for solid H_2. It is shown that grain temperatures as low as this may be attained in the interiors of dense clouds, due to the shielding effect by grains of the external interstellar radiation field. The photodissociating radiation is absorbed in a thin shell, and the time scale for recombination of atoms → molecules is $3 \times 10^4 - 3 \times 10^6$ years for densities of 10^4 to 10^2 cm^{-3}. It is therefore expected that almost all dense clouds will be molecular regions. The process of recombination lowers the density and temperature and may lead to contraction of the clouds and the beginnings of star formation. (auth)

4967 LONG-TERM BEHAVIOR OF THE SEYFERT GALAXY 3C 120. **Usher, P. D. (Pennsylvania State Univ., University Park); Shen, B. S. P.; Wright, F. W.; Shapley, H.; Hanley, C. M. Astrophys. J.; 158: 535-9(Nov 1969).**

The blue photographic luminosity of the nucleus of the Seyfert galaxy 3C 120 decreased by nearly 1 mag over a period of 4 years. The long-term behavior of 3C 120 is similar to that of the quasi-stellar object 3C 273B and provides another link in the phenomenological description of the two types of object. The time scale for the variability is an order of magnitude larger than the longest previously observed at radio and optical frequencies. (auth)

4968 STEADY-STATE FLUX OF POSITRONS AND THE AGE OF THE GALACTIC HALO. Lal, Siddheshwar; Brunstein, Karl (Univ. of Denver). Progr. Theor. Phys. (Kyoto), 42: 213-18 (Aug. 1969).

In solving the continuity equation that describes the intensity of cosmic-ray electrons and positrons in interstellar space, one makes the a priori assumption that steady-state condition exists. In this paper the condition under which this assumption is justified was investigated, and it is shown that if the cosmic rays are assumed to be confined uniformly throughout the galactic disc and the halo, then the age of the halo should be $\gtrsim 10^8$ years to account for the agreement between the calculated and observed flux of positrons in the primary component of cosmic rays. (auth)

4969 QUASI-STELLAR OBJECTS IN THE DIRECTION OF RICH CLUSTERS OF GALAXIES. Bahcall, John N. (California Inst. of Tech., Pasadena). Astrophys. J.; 158: L87-9(Nov 1969).

Fourteen quasi-stellar objects are listed that are in the direction of rich clusters of galaxies in Abell's catalog. The importance of making redshift measurements of galaxies with small angular separations from quasi-stellar objects with redshifts $\lesssim 0.2$ is discussed. (auth)

4970 COMPACT RADIO SOURCE IN THE NUCLEUS OF M87. Cohen, M. H. (California Inst. of Tech., Pasadena); Moffet, A. T.; Shaffer, D.; Clark, B. G.; Kellermann, K. I.; Jauncey, D. L.; Gulkis, S. Astrophys. J.; 158: L83-5(Nov 1969).

The compact radio source in M87 has been observed with a long-base-line interferometer composed of the 210-foot telescope at Goldstone, California, and the 85-foot telescope at Tidbinbilla, near Canberra, Australia. The observations suggest that the radio source is remarkably concentrated to the galactic nucleus and has a linear diameter of about 3 light-months. (auth)

4971 POSSIBLE VARIATIONS OF $\lambda = 10\ \mu m$ RADIATION FROM NGC 4151. Stein, W. A. (Univ. of California, San Diego. Univ. of Minnesota, Minneapolis. Kitt Peak National Observatory, Tucson, Ariz.); Gillett, F. C. Nature (London); 224: 675-6(15 Nov 1969).

Observations were made at $\lambda = 3.5$ and $11.5\ \mu m$ of the nucleus of the Seyfert galaxy NGC 4151 on June 21, 1969, with a view to looking for possible variations in the infrared flux, using a 36-in. telescope. Calculations of radiation processes applied to the infrared flux from Seyfert galaxies and the quasar 3C 273 indicated that it would be very unlikely that radiation from dust could be the source of such radiation if any significant variation were found at $\lambda = 10\ \mu m$. The results of the observations indicated that it is likely that a significant variation of the $\lambda = 10\ \mu m$ flux from NGC 4151 has occurred during the past one to two years, and thus it seems very unlikely that the $\lambda = 10\ \mu m$ infrared flux is due to radiation from dust in the nucleus of this object. (UK)

4972 DISTRIBUTION AND TEMPERATURE OF INTERSTELLAR ELECTRON GAS. **Bridle, A. H. (Queen's Univ., Kingston, Ont.); Venugopal, V. R. Nature (London); 224: 545-7(8 Nov 1969).**

Observational evidence is discussed which leads to the suggestion of a thick disk distribution for electrons in the interstellar electron gas. (auth) (UK)

4973 RANDOM NUMBER GENERATORS AND THEIR APPLICATION TO ASTRONOMICAL STATISTICAL PROBLEMS. **Meurers, J. (Univ., Vienna). Astron. Astrophys.; 3: 354-63(Nov 1969). (In German).**

Random number generators represent a new method for constituting and studying accidental events. In the following investigation, a "mixed" random generator is applied to the study of astronomical phenomena. By associating the members of the random series in various ways, it is possible to construct artificial two-dimensional star fields, star fields with random magnitude and spectral-type distributions, three-dimensional fields which can then be projected onto a plane, and two- and three-dimensional fields of velocity vectors. These constructions are random in the same sense as the number generators themselves; and all phenomena occurring in such random fields are accidental. If, therefore, similar phenomena are observed in real fields, additional evidence must be introduced to prove that they are not the result of pure chance. Artificial star fields produced from random number generators have the advantage of being built up point by point, so that it is possible to trace the development of various phenomena with increasing star density. It is shown that in artificial two-dimensional fields, holes, chains, and groups of stars occur as temporary chance phenomena. Chains with continuously decreasing magnitude are also possible. A two-dimensional projection of an artificial three-dimensional cluster also shows holes, chains and groups of stars. In addition, a "channel" from the center of the field to its edge appears and disappears as the density is increased. Finally, Markarian's chain of galaxies in the Virgo cluster is investigated to determine whether it could be an accidental phenomenon. A statistical comparison between the real chain and artificial point chains shows that the former could have been produced by chance. Additional physical criteria would be required to exclude this possibility. (auth)

4974 NEUTRAL HYDROGEN CONTENT OF SMALL GALAXIES. Gouguenheim, L. (Observatorie, Meudon, France). Astron. Astrophys.; 3: 281-307(Nov 1969).

The neutral hydrogen content of 49 galaxies was measured with the Nançay radiotelescope. A least-squares method of reduction was used, yielding best values of the parameters of the 21-cm line profile, together with their errors. The systemic velocities agreed with optical measurements. The velocity of the Sun with respect to the local Universe, established from the radial velocities of 37 galaxies less than 6 Mpc away from the Sun but outside the Local Group, was $V_0 = 250 \pm 40$ km s^{-1} towards $l^{II} = 130° \pm 20°$, $b^{II} = -9° \pm 8°$; Hubble's constant was found to be $H = 77 \pm 11$ km $s^{-1} \cdot Mpc^{-1}$. Correlations were found between several physical parameters. Particularly, a relation between the distance, the angular diameter, and the width of the 21-cm line profile of a galaxy allowed determination of distances within a factor 1.7; this method was used to determine distances of 6 galaxies. The correlations found between σ_{HI}/α and the type, τ, and between M_{HI}/L_* and τ are interpreted for spiral galaxies in a simple model, in which hydrogen is supposed to be distributed uniformly in a disk of diameter a and mean thickness a e. The assumption of a rate of star formation proportional to the square of the gas volumic density leads to estimates for the variation of relative thickness, e, and of average hydrogen density with type. (auth)

4975 THE RADIO SPECTRUM OF VIRGO A FROM 1411.7 TO 1423.8 MHz. Allen, R. J. (Observatoire de Paris-Meudon, France). Astron. Astrophys.; 3: 316-22(Nov 1969).

The radio spectrum of Virgo A near 21 cm wavelength was examined for evidence of "fine structure" (departures from a simple power law) using the large mirror radio telescope at Nançay. The method of observation must allow the measurement of spectral features which are expected to have widths up to several MHz and amplitudes of only a few parts in 10^3 of the average received signal. Special attention was therefore paid to an evaluation of the instrumental effects and to the calibration of the receiving system. Fine structure in the spectrum of Virgo A (and other sources) has been previously reported by Koehler and Robinson (1966), and attributed to the effects of absorption by intergalactic neutral atomic hydrogen. The results of these observations of Virgo A may be summarized as follows. Consider any two frequencies between 1411.7 and 1423.8 MHz which are separated by an interval $\Delta\nu$. Then $[\Delta S(\nu)/S(\nu)] \leqq 8 \times 10^{-4}$ for 280 kHz $\leqq \Delta\nu \lesssim$ 6 MHz, where $\Delta S(\nu)$ is the amplitude of departures from a simple power law for the source flux $S(\nu)$. The discrepancy between these results and those of Koehler and Robinson may arise partly from an instrumental effect which is much less important with the Nançay telescope. (auth)

4976 THERMAL INSTABILITIES IN THE INTERSTELLAR GAS. de Freitas Pacheco, J. A. (Observatoire, Nice). Astron. Astrophys.; 3: 368-71(Nov 1969).

The equilibrium conditions of the interstellar gas are calculated, supposing heating by cosmic rays and cooling by electron impact excitation of impurities. The results obtained are much more sensitive to the adopted chemical composition of the interstellar medium than those presented by Field et al. (1969). In this case possibilities are open to study the evolution of the physical conditions of the interstellar gas. (auth)

4977 A LIMIT ON THE VARIABILITY OF THE 22 MHz RADIATION FROM 3C 84 (NGC 1275). Roger, R. S. (Dominion Radio Astrophysical Observatory, Penticton, British Columbia). Astrophys. Lett. 4: 139-40(Nov 1969).

Braude et al. (1969) have reported variability in the radio emission from 3C 84 below 25 MHz. However, measurements at 22 MHz over eighteen months reveal no variability greater than 12% r.m.s. (auth)

4978 THE PERSISTENCE OF GALACTIC H I IRRADIATED BY A HOT INTERGALACTIC MEDIUM. Felten, James E.; Bergeron, Jacquelin (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett. 4: 155-7(Nov. 1969).

A recent argument that the neutral hydrogen observed in external galaxies precludes the existence of an intergalactic medium at $T_0 \sim 10^{6}$°K and $\rho_0 \sim 3H_0^2/8\pi G$ is incorrect. The ionizing flux can produce H II regions of emission measure $\sim 10^{-1}$ to 10^{-2} cm^{-6} pc above and below the H I disk of a galaxy. These regions are discussed in the Strömgren approximation; sample dimensions and densities are given. (auth)

Cosmology

4979 COOLING OF PRE-GALACTIC GAS CLOUDS BY HYDROGEN MOLECULES. Matsuda, Takuya; Sato, Humitaka; Takeda, Hidenori (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 42: 219-33(Aug. 1969).

According to the expanding hot Universe model, neutralization of the cosmic plasma ceases at the stage of radiation temperature $T_r \simeq 4000$°K. After that, a density contrast in the uniform medium grows into a contracting gas cloud with mass greater than 10^5 to 10^6 $M_\odot$. Hydrogen molecules are formed in the cloud after the stage of $T_r \simeq 300$°K, and the thermal evolution is largely affected by the cooling through H_2, whose processes are studied quantitatively in this paper. The present paper is a preliminary one for the more interesting problem of galaxy formation. (auth)

4980 RELATIVISTIC EFFECT IN PULSATING FLUID SPHERES. de Felice, F. (Cambridge Univ., Eng.). Nuovo Cim., 63B: 649-60(Oct. 11, 1969).

A relativistic effect of energy accumulation which arises when spherically symmetric configurations are enclosed in a sufficiently small volume is described. Conditions for a release of this energy are analyzed and possible physical applications of this effect are suggested. (auth)

4981 INTERACTION OF COSMIC GAMMA RAYS WITH INTERGALACTIC MATTER. Arons, Jonathan; McCray, Richard (Harvard Univ., Cambridge, Mass.). Astrophys. J.; 158: L91-5 (Nov 1969).

X rays and gamma rays emanating from large redshifts interact with intergalactic matter by Compton scattering and pair production. The maximum redshifts to observe discrete sources and diffuse background are calculated for evolutionary cosmological models of present densities 10^{-5} and 10^{-7} atoms cm^{-3}. Heating by the observed background and minimum equilibrium temperatures of the medium are estimated. (auth)

4982 ON THE NUMBER-MAGNITUDE RELATION FOR THE QUASI-STELLAR OBJECTS IN THE FIELD 13^h, + 36^0. Braccesi, A.; Formiggini, L. (Laboratorio Nazionale di Radioastronomia, Bologna). Astron. Astrophys.; 3: 364-7(Nov. 1969).

Magnitudes and colors of about 300 ultraviolet-excess objects were measured on plates obtained with the Palomar 48-in. Schmidt telescope. The four-color (u, b, v, i) system employed permits the QSO's to be identified on the basis of their combined ultraviolet and infrared excesses. The number versus magnitude relation for the QSO's was found to be much steeper than should be expected in the $\lambda = 0$, $q_0 = +1$ relativistic cosmological model, but to be consistent with the prediction made when the cosmological evolution suggested by Schmidt (1968) is taken into account. (auth)

4983 ISOTOPIC COMPOSITION OF COSMIC IMPORTANCE. Clayton, D. D. (Cambridge Univ., Eng.). Nature (London); 224: 56-7(4 Oct 1969).

Reference is made to the paper by the author (Astrophys. J. 139: 637 (1964)) in which it is concluded that ^{187}Os is primarily radiogenic, having resulted from the decay of ^{187}Re. This conclusion, however, is awkward for current cosmological thought due to the age of the Universe. Recent chronological models for natural radioactivities have tended to ignore ^{187}Re and do little to clarify when nucleosynthesis actually began. The present communication outlines a potentially important factor for ^{187}Re age, together with an isotopic measurement capable of clarifying the situation. If the weak nuclear decay ^{187}Re $(e^-\nu)$ ^{187}Os is much faster at star temperatures than on Earth, and if about 5% of terrestrial ^{187}Re has passed through stellar interiors hot enough to cause the decay but not so hot as to destroy ^{187}Re and ^{187}Os by nuclear reactions, then the terrestrial isotopic ratio ^{187}Os/^{186}Os can be significantly younger than the author's previous estimate. The potentially large effect of the thermal decay suggests two important questions: (1) will moderate stellar temperatures cause ^{187}Re to decay more rapidly?; and (2) can observational tests of enhanced decay be devised? Conceptually, the simplest possibility is the decay of thermally populated excited states, but this is unsatisfactory, as also is photon induced β decay. The most interesting possibility for enhancing the ^{187}Re decay appears to lie in the decay into bound states of the partially ionized atom, and this is discussed. Calculation of the ^{187}Re decay rate into bound states in stellar plasma is, however, difficult, but empirical tests might be possible. The obvious choice is somehow to measure the isotopic composition of Re or

Os in the Sun, or more practically in the solar wind. It is argued that the ^{187}Re half-life will be reduced from 43×10^9 yr to at least 3×10^9 yr, or less than the age of the Sun, and it is reasonable that ^{187}Re will be strongly depleted in the solar wind. The proposed test is to measure the isotopic composition of Re and Os in the solar wind; but it will be difficult to collect enough atoms to measure; it might be hoped, however, to find an area on the lunar surface which could have collected Re and Os from the solar wind for long periods, but reports from Apollo 11 make it seem unlikely that appropriate lunar surface areas exist. Such a test should eventually be undertaken if there is any reasonable chance of success since the underlying issues are fundamental. If ^{187}Re is not depleted in the solar wind it will be difficult to believe that it can decay appreciably faster in stars than in terrestrial minerals, in which case cosmology is presented with the problem of the large ^{187}Re age. (UK)

Planetary Phenomena

4984 THERMAL STRUCTURE OF THE IONOSPHERE OF VENUS. Whitten, R. C. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res.; 74: 5623-8(1 Nov 1969).

There are two possible heat sources for the sunlit ionosphere of Venus, photoionization of the neutral species, mainly CO_2, and influx from the solar wind. It is shown that the electron temperature should be substantially higher (at least ~500°K) than the temperature of the neutral atmosphere at altitudes above 250 km but that the ion temperature probably does not greatly exceed that of the neutral species. The significance of the solar wind as a heat source is also discussed. (auth)

4985 ESTIMATE OF RADIOGENIC ^{4}He AND ^{40}Ar CONCENTRATION IN THE CYTHEREAN ATMOSPHERE. Knudsen, William C.; Anderson, Albert D. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res.; 74: 5629-32(1 Nov 1969).

Mixing ratios of 2×10^{-4} and 1×10^{-4} for ^{4}He and ^{40}Ar, respectively, in a 100% CO_2 Mariner 5 model of the Cytherean lower atmosphere are derived by assuming that the ^{4}He and ^{40}Ar are secondary in origin and result entirely from radioactive disintegration with subsequent outgassing from the planet. Production rates on Venus are assumed equal to those for the Earth. Thermal escape of ^{4}He is shown to be negligible, and other loss mechanisms are assumed unimportant. Concentration of these gases in the upper atmosphere of Venus are calculated from the mixing ratios and a turbopause at 6180-km radius. The ^{4}He concentration in the upper atmosphere is a factor of 10 larger than the minimum value estimated by McElroy and Strobel [1969] to account for the observed nighttime ionosphere and is about a factor of 4 larger than that suggested by Whitten [1969] to explain the observed daytime ionosphere. This degree of agreement among three separate approaches strengthens the possibility that ^{4}He is a dominant constituent in the upper atmosphere of Venus and also implies that loss of ^{4}He on Venus by plasma expansion is unimportant. ^{4}He will be the dominant constituent out to a radius of about 7600 km if H_2 is present at the upper limit suggested by McElroy and Hunten [1969] and out to a radius of about 8700 km if H_2 is negligible. (auth)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

4986 (UCRL-50691) MEASUREMENT OF X-RAY-INDUCED ELECTRON CURRENTS FROM METAL TARGETS. Ebert, P. J.; Gaines, J. L.; Leipelt, G. R. (California Univ., Livermore. Lawrence Radiation Lab.). June 23, 1969. 29p. Dep. CFSTI.

Secondary electron currents are produced by monoenergetic x rays incident on metallic targets. In this study, secondary electron yields were measured as a function of x-ray energy, target thickness, and atomic number. (auth)

4987 ENERGY AND INTENSITY AFTER MULTIPLE BACK SCATTERING OF BETA PARTICLES ON NUCLEI OF DIFFERENT ELEMENTS. Boyarshinov, L. M. (Moscow Inst. of the Technology of Fine Chemicals). Dokl. Akad. Nauk SSSR, 186: 545-8(1969). (In Russian).

Backscattering is widely used to determine the content of a component in a binary mixture. The sensitivity of the method is significantly increased on using double or even multiple backscattering. The beta intensity is decreased approximately by a factor of 5 with each backscattering. With the use of a thallium-204 beta source (0.5 microcuries) and an end-window beta counter, measurements of intensity and maximum beta energy were carried out after two backscatterings on matter of low Z such as carbon, aluminum, and titanium, after four backscatterings on material of average Z such as copper and molybdenum, and after six backscatterings on material of high Z such as lead. Simple formulas were derived to represent the data. These formulas give the maximum energy and intensity of the beta particles after multiple electron scattering as a function of the atomic number of the scattering material and number of back scatterings. (TTT)

4988 INVESTIGATION OF THE DEPTH DISTRIBUTION OF CHARACTERISTIC X RAYS OF BORON, CARBON, ALUMINUM, AND SILVER EXCITED BY ELECTRON BOMBARDMENT. Hoffmann, L.; Wiech, G.; Zoepf, E. (Univ., Munich). Z. Phys., 229: 131-53(1969). (In German).

The peak intensity of the x-ray emission bands of boron (B K; 67 Å), carbon (C K; 44 Å), aluminum (Al $L_{2,3}$; 171 Å), and silver (AG Mζ; 40 Å) excited by electron bombardment of evaporated targets has been measured as a function of the thickness of the target and at several accelerating voltages in the range 1 to 4 kV. The electron beam was inclined at an angle of 50° to the surface of the target; the take-off angle for the radiation was about 20°. From these measurements, the thickness of layers effective in producing x rays may be obtained. The influence of surface contamination and oxide layers on the intensity distribution of emission bands is discussed. It is then shown that the effect of anode self-absorption can be evaluated, if the absorption coefficient $\mu(\lambda)$ is available. As an example the L_3/L_2 intensity ratio of aluminum, and an averaged depth of x-ray production are calculated; moreover data for the electron range are given and compared with earlier results. Finally the B K-emission band of evaporated boron is presented. (auth)

4989 FURTHER STUDIES OF THE ABSOLUTE INTENSITY OF EMISSION OF CHARACTERISTIC X RADIATION. Fong, L. H.; Tomlin, S. G. (Adelaide Univ.). Aust. J. Phys., 22: 459-70(Aug. 1969).

The theory of Metchnik and Tomlin (1963) relating to the characteristic x-ray yield from thick targets bombarded with electrons is further discussed and a simple formula is developed from it. Some selected results from an extensive experimental study of x-ray yield are presented and these are compared with other published results and various theoretical discussions. (Australia)

4990 CORRECTION OF LANDAU'S ENERGY LOSS FORMULA. Maccabee, H. D.; Papworth, D. G. (Medical Research Council, Harwell, Eng.). Phys. Lett., 30A: 241-2(Oct. 20, 1969).

Landau derived an expression for the most probable energy loss by ionization for fast charged particles traversing thin absorbers. More accurate calculations of this quantity indicate that Landau's value is slightly too large. (auth)

Atomic and Molecular Properties

Refer also to abstract 5333.

4991 (BARC-286) DYNAMICS OF LIQUID CD_4 FROM COLD NEUTRON SCATTERING. Venkataraman, G.; Dasannacharya, B. A.; Rao, K. R. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 38p. Dep. CFSTI (U. S. Sales Only).

The scattering of 4.1 Å neutrons by liquid CD_4 at 95°K was studied at several angles of scattering covering the first liquid diffraction peak. The spectra are strikingly different from those observed in liquid CH_4, with the quasi-elastic peak being very much more prominent than in liquid CH_4 at large scattering angles. The width of the quasi-elastic peak shows an oscillatory behaviour as a function of momentum transfer, with a minimum at the diffraction peak. Expressions are derived for the scattering of slow neutrons by a monomolecular system under the assumption of no vibrational scattering and weak anisotropic forces. In applying the theory to liquid CD_4, two models (A and B) are considered. In both models, the single particle translational motions are assumed to have a simple diffusion behaviour, while collective motions are described by an intermediate scattering function with a structure dependent damping. The rotations are treated as free in model A and as hindered in model B. The first and second order relaxation functions for the hindered rotator are derived from infrared-red and Raman data respectively as suggested by Sears. Both models make essentially the same predictions for the quasi-elastic widths, and these are found to be in fair agreement with experiment. Examination of the various contributions to the total spectrum in both models shows that the difference in the spectra for CD_4 and CH_4 are partly due to intra-molecular effects which reduce the rotational inelastic intensity and enhance the quasi-elastic, and partly due to inter-molecular effects which also boost the quasi-elastic. It is further found that spectra predicted by the two models are very nearly the same unlike the case of liquid CH_4 where hindering of the rotation influences the spectrum considerably. This is a consequence of the fact that rotational effects appear mainly via incoherent scattering which is small in the case of CD_4. Comparison with experiment shows that our models are able to explain qualitatively the important differences between the spectra for CH_4 and CD_4. Quantitative agreement is, however, lacking and indicates the need for improved models for the center of mass motions. (auth)

4992 CRITICAL EVALUATION OF TRANSITION PROBABILITIES FOR Ba I AND Ba II. Miles, B. M.; Wiese, W. L. (National Bureau of Standards, Washington, D. C.). At. Data; 1: 1-17(Sep 1969).

Transition probabilities for allowed lines of Ba I and II, based on a critical evaluation of available literature sources, are presented in order of increasing quantum numbers. (auth)

Collision Phenomena

Refer also to abstract 5266.

4993 LOW-ENERGY ELECTRON-COLLISION CROSS-SECTION DATA. PART I. IONIZATION, DISSOCIATION, VIBRATIONAL EXCITATION. Kieffer, L. J. (Univ. of Colorado, Boulder). Contract DA-31-124-ARO-D-139. At. Data; 1: 19-89(Sep 1969).

Graphical displays of selected experimental data on cross sections as functions of electron energy are presented for some 60 targets important in aeronomy, astrophysics, and plasma physics. The processes covered are ionization, dissociation, and vibrational excitation. Criteria for data selection are discussed. The literature available up to September 1968 has been searched. (auth)

4994 PHOTODISSOCIATION OF VIBRATIONALLY EXCITED H_2, HD, AND D_2 BY ABSORPTION INTO THE CONTINUA OF THE LYMAN AND WERNER SYSTEMS. Allison, A. C.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). At. Data; 1: 91-102(Sep 1969).

Results are presented of calculations of the photodissociation cross sections corresponding to absorption from all the vibrational levels of the ground electronic state, $X^1\Sigma_g^+$, of H_2 and its isotopes, HD and D_2, into the continua of the Lyman ($B^1\Sigma_u^+$) and the Werner ($C^1\Pi_u$) systems. (auth)

4995 EMISSION CROSS SECTION OF N II LINES PRODUCED BY ELECTRON IMPACT ON NITROGEN. Srivastava, B. N. (Univ. of Alaska, College). J. Quant. Spectrosc. Radiative Transfer.; 9: 1639-41(Dec 1969).

Cross sections were measured for the emission of N II lines excited by electron impact on N_2 in the energy range 150 eV to 4 keV. The energy behavior of all the lines is the same and is similar to the total ionization cross section of N_2 and the N_2^+ first negative band emission cross section above 600-eV electron energy. (auth) (UK)

4996 OPACITY ANALYSIS OF INELASTIC MOLECULAR COLLISIONS. I. THE QUANTUM MECHANICAL SUDDEN APPROXIMATION. Levine, R. D. (Ohio State Univ., Columbus). Chem. Phys. Lett; 4: 211-13(1 Nov 1969).

The quantum mechanical "sudden" approximation, valid in the limit of small momentum transfer, is discussed and applied to the quenching of glory extrema in rotational excitation. Physically, the approximation corresponds to the rotational degrees of freedom being "frozen" during the mutual (elastic) scattering. (auth)

4997 CALCULATED TOTAL ELASTIC SCATTERING CROSS SECTIONS FOR H(1S) + H(1S) AT COLLISION ENERGIES BELOW 1 eV. Gersh, Michael E.; Bernstein, Richard B. (Univ. of Wisconsin, Madison). Chem. Phys. Lett.; 4: 221-3(1 Nov 1969).

Exact computations of the elastic scattering cross sections for atomic hydrogen, based on the best local ${}^1\Sigma_g^+$ and ${}^3\Sigma_u^+$ potentials, provide an accurate, essentially ab initio prediction of glory and resonance behavior to be expected in H(1S) beam scattering experiments. (auth)

4998 IONIZATION OF HELIUM BY HIGH-ENERGY ELECTRONS. Bell, K. L.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London); 2: 1125-30(Nov 1969).

The cross section for ionization of helium by electron impact is calculated using the Born approximation. Accurate wave functions are employed for both the ground and continuum states, the l = 0, 1, and 2 partial waves of the continuum state are represented by polarized-orbitals wave functions, the l = 3, 4, and 5 partial waves are represented by Hartree–Fock wave functions, and the ground state of helium is represented by a six-parameter correlated wave function. The cross section is obtained using both the length and velocity formulations of the Born matrix element. A comparison is made with previous calculations and measurements. (auth) (UK)

4999 THERMAL-ENERGY ATOM-MOLECULE COLLISIONS. Burke, P. G. (Queen's Univ., Belfast); Scrutton, D.; Tait, J. H.; Taylor, A. Joanna. J. Phys., B (London); 2: 1155-68(Nov 1969).

The rotational excitation in Ne–N_2 scattering for energies from threshold to 0.5 was studied using a potential interaction obtained from viscosity data and polarizabilities of the pure gases. The cross sections below 0.006 eV were found to be dominated by resonances that are either shape resonances or Feshbach resonances. These two types of resonance are related using the idea of analyticity in angular momentum introduced by Regge. (auth) (UK)

5000 MEASUREMENTS OF ANGULAR DISTRIBUTIONS OF ELECTRONS ELASTICALLY SCATTERED BY HELIUM. Gibson, J. R.; Dolder, K. T. (Univ. of Newcastle-upon-Tyne, Eng.). J. Phys., B (London); 2: 1180-6(Nov 1969).

Differential cross sections were measured for electrons with energies between 3.1 and 19.1 eV elastically scattered by helium. The scattering angles ranged from 25 to 145°. The results are compared with the measurements of Ramsauer and Kollath (1931 and 1932), theoretical predictions, and cross sections recommended by Bransden and McDowell (1969) from an analysis of a wide variety of experimental data. The present results are closer to the theoretical predictions and recommended cross sections than the measurements by Ramsauer and Kollath, particularly at the smaller energies and angles. (auth) (UK)

5001 PHASE-SHIFT ANALYSIS OF ELECTRON–HELIUM SCATTERING. I. ELASTIC SCATTERING BELOW THE ${}^2S$ RESONANCE. Bransden, B. H.; McDowell, M. R. C. (Univ. of Durham, Eng.). J. Phys., B (London); 2: 1187-1201(Nov 1969).

A phase-shift analysis of electron–helium elastic scattering in the energy range 3.1 to 19.1 eV was made; s- and p-wave phase shifts consistent with the dispersion relation and with experimental information on the total elastic scattering cross section, the diffusion cross section, and recent measurements of the differential cross section, to within 5%, were obtained. The Gibson–Dolder (1969) measurements of the differential scattering cross section are shown to be theoretically preferable to the earlier measurements of Ramsauer and Kollath (1932). The d-wave phase shift cannot be determined to better than 25% by available experimental information. The phase shifts obtained are consistent with, but do not distinguish between, recent nonadiabatic theoretical calculations, but exclude the simple polarized orbital model. They satisfy Spruch bounds based on the experimental polarizability and yield a scattering length of 1.1 a_0 in agreement with other determinations. (auth) (UK)

5002 APPLICATION OF A SIMPLIFIED SECOND BORN APPROXIMATION TO THE SCATTERING OF ELECTRONS AND PROTONS BY HYDROGEN ATOMS. II. Holt, A. R. (Univ. of Essex, Colchester, Eng.). J. Phys., B (London); 2: 1202-8 (Nov 1969).

The simplified second Born approximation is applied to the 1s → 3s, 1s → 3p, 2s → 3s excitations of atomic hydrogen by both electron and proton impact. The excitations from the ground state give total cross sections that behave similarly, with respect to the respective first Born cross sections, to those previously calculated for the 1s → 2s, 1s → 2p excitations; they indicate that the first Born total cross sections for optically allowed excitations are reliable over a larger energy range than those for optically forbidden excitations. (auth) (UK)

5003 ON THE ACCURACY OF THE SIMPLIFIED SECOND BORN APPROXIMATION. Holt, A. R. (Univ. of Essex, Colchester, Eng.); Moiseiwitsch, B. L. J. Phys., B (London); 2: 1253-5(Nov 1969).

The accuracy of the simplified second Born approximation calculations of Holt and Moiseiwitsch (1968) on the 1s → 2s and 1s → 2p excitations of atomic hydrogen by proton impact is assessed by comparing with the zero- and first-order approximations of Cheshire and Sullivan (1967). (auth) (UK)

5004 ELECTRON SCATTERING BY ATOMIC HYDROGEN USING A PSEUDO-STATE EXPANSION. I. ELASTIC SCATTERING. Burke, P. G. (Queen's Univ., Belfast); Gallaher, D. F.; Geltman, S. J. Phys., B (London); 2: 1142-54(Nov 1969).

A modified close-coupling expansion was developed and applied to calculate elastic electron–hydrogen atom scattering phase shifts. This expansion into a complete discrete orthonormal basis set is a variant of the more usual close-coupling expansion into eigenstates of the target Hamiltonian. The first few hydrogen atom eigenstates are retained and these terms are augmented with pseudostates chosen, in this particular case, to incorporate fully the ground-state polarizability of the hydrogen atom. The resulting phase shifts are compared, where possible, with those obtained in the most accurate variational calculations available, and they indicate a distinctly improved convergence over those obtained in the more usual close-coupling expansion. (auth) (UK)

5005 TWO-CHANNEL MODEL FOR ELECTRON TRANSFER IN ION–MOLECULE COLLISIONS. North, G. R.; Leventhal, J. J. (Univ. of Missouri, St. Louis). J. Chem. Phys.; 51: 4236-7 (15 Nov 1969).

A phenomenological model based on competition between charge-transfer and atomic-rearrangement (chemical reaction) channels is used to calculate the charge-exchange cross section for Ar^+-H_2 collisions below 1000 eV. The energy dependence of the calculated cross section is in good agreement with recent data. (auth)

5006 HIGH-RESOLUTION PHOTOIONIZATION STUDY OF THE H_2 MOLECULE NEAR THRESHOLD. Chupka, W. A.; Berkowitz, J. (Argonne National Lab., Ill.). J. Chem. Phys.; 51: 4244-68(15 Nov 1969).

Relative photoionization and absorption cross sections of H_2 (ordinary and para) were measured from 745 to 810 Å at 300 and 78°K, with a resolution width of 0.04 Å. The photoionization data show the presence of extensive structure due to autoionization of vibrationally excited Rydberg states. Analysis of the data on the D–X(6,0) band in the region of the ionization threshold leads to the conclusion that the ionization potential of H_2 lies between 124 418.2 and 124 393.5 cm^{-1} and is probably very near the former value. Analysis of the data on the B″–X(4,0) band requires either that the ionization potential lies below 124 407.2 cm^{-1} (which is rather unlikely) or that autoionization of the R(2) and R(3) lines occurs in violation of one of the autoionization selection rules proposed by Beutler and Jünger. Some Rydberg states that lie just below their ionization limits and do not autoionize spontaneously can be made to ionize in weak electric fields and by collision with unexcited H_2 molecules. Direct ionization of H_2 ($J = 0$) appears to begin about 23 cm^{-1} below the expected threshold, probably as a result of collisional ionization of Rydberg states lying just below the ionization threshold. A series of peaks appearing in a short region immediately above threshold apparently coincides with a series that Herzberg has observed in absorption and identified as the Rydberg series converging to the rotationally excited $K = 2$ state of the H_2^+ ion. The autoionization of these Rydberg states must occur by conversion of rotational to electronic energy. An intensity anomaly of this series is ascribed to channel interaction with a vibrationally excited Rydberg state. A large number of the autoionization peaks have been identified in the spectrum of parahydrogen at 78°K. By comparison of the absorption cross section with the photoionization cross section, it was found that all states that can autoionize with $\Delta v = 1$ are strongly autoionized (~40%–100%) while the autoionization probabilities of states that autoionize with $\Delta v > 1$ vary widely. The dominance of autoionization with $\Delta v = 1$ over predissociation extends to the very highest Rydberg states and leads to the absence of observable thresholds for formation of vibrationally excited H_2^+ ions. Some peaks that autoionize with $\Delta v = 1$ have widths larger than the instrumental width, and the autoionization rates have been estimated. They are in fair quantitative agreement with recent calculations of Nielsen and Berry. The widths decrease rapidly with principal quantum number as Bardsley predicts. The autoionization rate decreases by about a factor of 10 or more when the Δv of the transiton changes from 1 to 2. For larger values of Δv, the autoionization rate appears to decrease still more but not necessarily as a monotonic function of Δv. (auth)

Atomic Theory

Refer also to abstract 5321.

5007 ANALYTIC OPTIMIZATION IN ATOMIC SCF CALCULATIONS. Olive, Joseph P. (Univ. of Chicago). J. Chem. Phys.; 51: 4340-3(15 Nov 1969).

For self-consistent-field calculations by the expansion technique, equations were derived that incorporate the optimization of the exponents as well as the coefficients of the Slater-type basis functions. The equations were programed for a computer, and the program was tested for small atoms. (auth)

5008 GENERALIZED X-RAY SCATTERING FACTORS. Stewart, Robert F. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 51: 4569-77(15 Nov 1969).

Generalized x-ray scattering factors were determined from the evaluation of Fourier transforms of atomic-orbital products. Self-consistent-field atomic orbitals for first-row atoms were studied. Analytical scattering expressions for rapid evaluation on digital computers were developed. Scattering factors from small GTO expansions were compared with both Clementi and Huzinaga SCF atomic orbitals. For one-center orbital products, the three-set GTO atomic orbitals agree with full SCF scattering factors to within five parts per hundred or better; the four-set GTO expansions have relative differences of 1.5% or less. For the two-center scattering cases, three or more Gaussians per atomic orbital yield relative errors less than 1%. The generalized x-ray scattering factors can serve as basis functions in the analysis of charge densities from x-ray diffraction data. (auth)

Cosmic Radiation

Refer also to abstracts 4968, 4981, 5048, 5072, 5079, 5248, and 5283.

5009 (AECL–3425) COSMIC RAY MT-64 MUON MONITOR DATA. II. SOLAR ROTATION 1813 TO ROTATION 1825, JANUARY 20, 1966–JANUARY 5, 1967. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1969. 81p. Dep. CFSTI (U. S. Sales Only). CAN $2.00.

Hourly rates corrected for atmospheric temperature and pressure from four cosmic-ray stations in Canada that have muon monitors maintained by AECL and from a survey monitor stationed at Kula, Hawaii, are given in tabular form by solar rotation for the period from the beginning of Rotation 1813 to the end of Rotation 1825 (January 20, 1966 to January 5, 1967). The Dorman–Maeda tamperature correction factors for each station calculated at 12-hour intervals from the radiosonde data of the Canadian Meteorological Branch and the U. S. Weather Bureau are also listed. Barometric pressures are available from neutron monitor data reports already published. Graphs of the relative hourly rates at each station are given. (auth)

5010 (HASL–213) A MONTE CARLO SIMULATION OF THE TRANSPORT OF HIGH-ENERGY ELECTRONS AND PHOTONS IN MATTER. Beck, Harold L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Oct 1969. 25p. Dep. CFSTI.

A Monte Carlo computer code which simulates the longitudinal development of electromagnetic showers is described. This code includes a statistical estimation option for computing differential fluxes, separate scoring of positrons and negatrons, allowance for annihilation in flight, and corrections for the density effect in the formulas for the electron stopping power. Calculations using this code are in good agreement with experimental results and comparable Monte Carlo calculations of other investigators. (auth)

5011 (N–69–33435) LOW ENERGY COSMIC RAY POSITRONS AND 0.51-MeV GAMMA RAYS FROM THE GALAXY. Ramaty, R.; Stecker, F. W.; Misra, D. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1969. 25p. (NASA-TM-X-63620; X–611-69-287). CFSTI.

Large fluxes of low-energy cosmic rays in interstellar space may produce, via unstable CNO beta emitters, large fluxes of low-energy positrons and a detectable intensity of 0.51-MeV gamma rays. Even though on a galactic scale these cosmic-ray intensities are probably untenable since they conflict with the dynamics of the interstellar medium, they may exist on a smaller scale of the order of the stopping distances of both low-energy cosmic rays and positrons. Results are compared of a detailed calculation with direct positron measurements at the Earth, and the observability of the annihilation radiation above the isotropic x-ray background is discussed. (auth) (STAR)

5012 (N–69–33438) RESEARCH FOR THE MEASURING OF NEUTRON INTENSITY IN SPACE. Final Report. Lockwood, J. A. (New Hampshire Univ., Durham. Dept. of Physics). June 1969. Contract NASr-164. 168p. (NASA-CR–103825). CFSTI.

The results of measurements are reported of (1) the fast neutron flux and energy spectra near the top and above the Earth's atmosphere, and (2) the electron density in the ionosphere. Observations were made both on rocket and balloon flights at several different epochs and at a range of geographic latitudes. Included are measurements of solar x rays and solar ultraviolet radiation. Also contained in the report is a collection of all the publications pertaining to the above investigations which are arranged chronologically and are divided into two groups: cosmic-ray neutron and ionospheric measurements. (auth) (STAR)

5013 (N-69-35721) REVIEW OF OBSERVATIONAL RESULTS ON GAMMA RAY BACKGROUND. Clark, G. W.; Garmire, G. P.; Kraushaar, W. L. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics. California Inst. of Tech., Pasadena. Wisconsin Univ., Madison). [1969]. 20p. (NASA-CR-105310). CFSTI.

Recent observations in the x- and gamma-ray region of the electromagnetic spectrum have given strong evidence for the existence of an extragalactic intensity with a slowly steepening power law spectrum in the region 10^3 to 10^8 eV. Improved data from the OSO-3 high-energy gamma-ray detector are in agreement with earlier published reports and suggest that the gamma rays from high galactic latitudes have a softer spectrum than those from the galactic plane. (auth) (STAR)

5014 (ORNL-tr-2207) STUDY OF GAMMA RADIATION BETWEEN 0.1 AND 1 MeV IN THE EARTH'S ATMOSPHERE. Boclet, Daniel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-R-3177. 93p. Dep. CFSTI.

An abstract of the original French report appeared in NSA 22: 13261. (L.M.T.)

5015 CHARGE COMPOSITION AND ENERGY SPECTRUM OF PRIMARY COSMIC-RAY ELECTRONS. Fanselow, J. L.; Hartman, R. C.; Hildebrand, R. H.; Meyer, Peter (Univ. of Chicago). Astrophys. J.; 158: 771-80(Nov 1969).

The flux, energy spectrum, and charge composition of the electron component of primary cosmic rays was measured in 1965 and 1966 in the range from 170 MeV to 14.3 BeV, and a finite flux of positrons was observed up to 4 BeV. The positron fraction $N^+/(N^+ + N^-)$ is shown to decrease as a function of energy. For the first time, it was possible to determine the energy spectrum of primary positrons above 220 MeV. To approximate this observed spectrum above 860 MeV by a power law requires an exponent of 2.6 ± 0.5, consistent with negligible modification of the source spectrum below 10 BeV by energy-loss processes. Comparison of the differential energy spectrum of positrons with calculations based on a collision origin leads to a reasonable agreement for a disk model with passage of cosmic rays through 3 to 4 g cm^{-2} of interstellar material and modulation parameters $\eta = 0.6$ BV and $R_0 = 0.3$ BV. (auth)

5016 EFFECT OF GALACTIC COSMIC RAYS UPON THE DYNAMICS OF THE SOLAR WIND. Sousk, Stephen F.; Lenchek, Allen M. (Univ. of Maryland, College Park). Astrophys. J.; 158: 781-95(Nov 1969).

The scattering of galactic cosmic rays by the fluctuations in the magnetic field embedded in the solar wind transfers energy momentum to the cosmic-ray gas. The hydrodynamic equations of the wind, including both these effects, are integrated. The nature of the solutions depends critically on the model chosen for the variation of the diffusion coefficient K with heliocentric distance. It is found that, in order to obtain solutions which give reasonable values for the cosmic-ray pressure at infinity, the diffusion coefficient must vary with heliocentric distance in such a way that, at distances greater than ~4 A.U., K increases to a value very much larger than its value at 1 A.U. With such models of K(r) the cosmic-ray gas then exerts only a small influence on the wind. (auth)

5017 A STUDY OF MUONS DEEP UNDERGROUND. I. ANGULAR DISTRIBUTION AND VERTICAL INTENSITY. Stockel, C. T. (Northern Polytechnic, London). J. Phys., A (London); 2: 639-49(Nov 1969).

The angular distribution and vertical intensity of cosmic-ray muons were measured at depths of 71.6, 734, 1068 and 2235 hg cm^{-2} of standard rock. The angular distribution was fitted by a law of the form $I_\theta = I_v \cos^n\theta$ and values of the exponent n were found to be 1.8 ± 0.1, 2.1 ± 0.1, 2.3 ± 0.1 and 3.6 ± 0.2 respectively. The corresponding vertical intensities were found to be $(5.00 \pm 0.17) \times 10^{-4}$, $(3.12 \pm 0.15) \times 10^{-6}$, $(1.03 \pm 0.04) \times 10^{-6}$ and $(9.7 \pm 0.5) \times 10^{-8}$ cm^{-2} s^{-1} sr^{-1} respectively. From a survey of all previous measurements best estimates of the n-depth and intensity–depth curves are derived. The results are explicable entirely in terms of pion and kaon decay for the origin of the muons and do not agree with the direct muon production hypothesis advanced by Bergeson et al. in 1967. (auth) (UK)

5018 2 TO 20-keV X-RAY SKY BACKGROUND. Boldt, E. A.; Desai, U. D.; Holt, S. S.; Serlemitsos, P. J. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 224: 677-9(15 Nov 1969).

The results of a rocket flight from White Sands, New Mexico, on March 3, 1969, are reported, the object being investigation of the diffuse x-ray background within the 2 to 20 keV band. A description of the telescope employed is given; this included six argon-filled proportional counters constructed of Be, enclosed in an anti-coincidence shield of plastic scintillator. Measurements were made above 250,000 ft. The first part of the exposure was devoted to a measurement of Sco X-1, while the second part comprised a scan of about 1° per second along a great circle from Sco X-1 to an extended stop at the north galactic pole. The count rate at mid-galactic latitudes was within 5% of that at the north galactic pole. In order to evaluate the spectrum of the incident flux a power law for a range of spectral indices was assumed and these hypothetical spectra were folded though the measured response functions of the detectors. Limits of 1.25 and 1.42 were found for the spectral index, and the results ruled out an index larger than 1.6. There were strong indications that the index was close to 1.4. The results gave a spectrum for the diffuse background over the band 2 to 20 keV as 10.3 E^{-n} photons/(cm^2-S-St-keV) where E is the photon energy in keV and $n = (1.35 ^{+0.07}_{-0.10})$. Taking account of the results of other studies all the results suggest a change in spectral index of about unity within the interval 20 to 80 keV; reasons for such a spectral index change are discussed. The universal bremsstrahlung of suprathermal protons with the ambient electrons of the intergalactic medium probably provides the only natural set of circumstances for a spectral break in the correct energy region. (UK)

5019 CHANGES OF THE EARTH'S MAGNETIC MOMENT AND RADIOCARBON DATING. Bucha, V. (Geophysical Inst., Prague). Nature (London); 224: 681-2(15 Nov 1969).

Studies on changes in geomagnetic intensity are reviewed in relation to radiocarbon dating of archeological specimens. It was found that a decrease in magnetic moment is followed by an increase in cosmic-ray flux and, therefore, by an increase in the production of ^{14}C; higher values of the field have the opposite effect. A deviation of 1% in ^{14}C production appears to correspond to a change of 0.645×10^{25}G cm^3 in the Earth's magnetic moment. (UK)

5020 DISINTEGRATION AND ENERGY DEGRADATION OF VERY HIGH-ENERGY COSMIC RAYS IN INTENSE PHOTON FIELDS. Pollack, James B. (Cornell Univ., Ithaca, N. Y.); Shen, B. S. P. Phys. Rev. Lett.; 23: 1358-61(8 Dec 1969).

Very high-energy cosmic rays, on emerging from their places of origin, are subject to photodisintegration and energy degradation by blue-shifted photons. It is shown that the intense photon fields of supernova explosions, of quasistellar objects, and of one of the current pulsar models are able to cause complete disintegration of complex nuclei and significant energy losses of protons at energies consistent with observed changes in the cosmic-ray charge and energy spectrum, respectively. (auth)

5021 LOW-ENERGY GAMMA RADIATION IN THE ATMOSPHERE AT MIDLATITUDES. Haymes, R. C.; Glenn, S. W.; Fishman, G. J.; Harnden, F. R. Jr. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 74: 5792-5805(1 Nov 1969).

Balloon-borne experiments with directional scintillators that measured the spectrum of gamma radiation with energies between 30 and 570 keV in the atmosphere up to 130,000 feet were conducted during 1967 and 1968. These data are of interest in connection with understanding the origin of atmospheric photons and with estimating planetary and stellar gamma albedos, as well as effecting improvements in gamma-ray astronomy. The measurements, conducted in the United States and in Australia, showed that a continuum and structure are present at depths X greater than 90 g cm^{-2}; the intensity of the continuum depends exponentially on depth for $X \geq 102$ g cm^{-2}, but the shape is relatively depth-independent. The spectrum softens considerably at lesser depths. Structure is observed in the spectrum at 130,000 feet, superimposed on a continuum approximated by the power law $27.8E^{-1.67}$ photons cm^{-2} sec^{-1} $ster^{-1}$ keV^{-1}. The latitude, altitude, and energy variations of the spectrum are discussed in terms of the various depths for the spectrum; it is shown that several factors are responsible for the continuum and that the observed structure is mainly due to (n,γ) effects from cosmic-ray neutrons, and an upper limit is established for a line flux at 511 keV. The 95% confidence level upper limit of 0.2 photon cm^{-2} sec^{-1} for line radiation at the positron annihilation energy is slightly below the fluxes previously reported by others. (auth)

5022 SIDEREAL COSMIC-RAY DIURNAL VARIATIONS. Swinson, Derek B. (Univ. of New Mexico, Albuquerque). J. Geophys. Res.; 74: 5591-8(1 Nov 1969).

New data from underground μ-meson telescopes, at depths of 40 mwe, in the northern and southern hemispheres are presented. Analysis in sidereal time of three years of data from the northern hemisphere telescopes and two years of data from the southern hemisphere telescopes confirms that a maximum intensity is observed near 18 hours sidereal time for telescopes pointing into the northern hemisphere and near 06 hours sidereal time for telescopes pointing into the southern hemisphere, in agreement with previous observations by others. A model is proposed in which just such a "sidereal" variation can be produced in the vicinity of the Earth as a result of the radial cosmic-ray density gradient and the interplanetary magnetic field; the model is tested by dividing the cosmic-ray data according to the direction of the interplanetary field and performing the same sidereal time analysis on these data. The results confirm the principal features of the model and demonstrate that the "sidereal" variation can be produced in the inner solar system, correctly predicting the observed times of maximum in the northern and southern hemispheres, without recourse to assumptions about anisotropies of the particle flux in galactic space. (auth)

5023 COSMIC-RAY INTENSITY VARIATIONS ON JANUARY 26–27, 1968. Lockwood, J. A.; Webber, W. R. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 74: 5599-5610(1 Nov 1969).

A Forbush decrease of about 4% was recorded on January 26 by the Mt. Washington cosmic-ray neutron monitor after a sc magnetic storm. Since measurements outside the magnetosphere of both the magnetic field (Explorer 33) and the cosmic-ray flux for protons with $E > 14$ MeV (Pioneer 8) are available, geomagnetic perturbations of the local cosmic-ray flux are separated from changes of the flux in space. The main phase of the Forbush decrease at 2100 UT on January 26 followed a disturbance in the magnitude and direction of the interplanetary magnetic field at about 1430 UT. The observed ratio of the amplitude for the cosmic-ray decrease in space to that recorded at Mt. Washington was 1.7. An east–west anisotropy of ~4% persisted in the cosmic-ray flux for 16 hours, the intensity being depressed west of the Earth–Sun line. For about six hours around 1800 UT there was a north–south anisotropy of 4%, the net flux directed southward. The anisotropy measured by the Pioneer detector ($E > 60$ MeV) after the Forbush decrease is greater in magnitude and persists longer than indicated by neutron monitors. These features are related to the quasi-stationary cosmic-ray flow patterns. (auth)

Direct Energy Conversion

5024 (FEI–148) CONCERNING LOW-FREQUENCY OSCILLATIONS IN A HIGH-PRESSURE PLASMA DIODE. Zherebtsov, V. A.; Stakhanov, I. P. (Gosudarstvennyi Komitet po Pspol'zovaniyu Atomnoi Energii SSSR, Moscow. Fiziko-Energeticheskii Institut). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The stability of a plasma diode is examined with respect to low-frequency, longwave oscillations. It is shown that a diode can be unstable even with considerable dissipation in the interelectrode gap because of collisions of charged particles with neutral ones. Instability is related to the presence of feedback between the near-cathode and near-anode regions. (auth)

5025 (IPP–2/79) POTENTIAL DISTRIBUTION IN A TWO-EMITTER-DIODE. Troppmann, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 62p. (In German). Dep. CFSTI (U. S. Sales Only).

The existing model of a "collisionless" alkali plasma diode is extended including the case of two incandescent plane electrodes emitting electrons as well as ions with half-Maxwellian velocity distributions. The potential distributions derived from this theory are examined in detail. Physically necessary conditions reduce the well-known ambiguity of solutions to a single one (with uniform plasma potential) at a given set of parameters. Further solutions, corresponding to spatially oscillatory potential shapes which are consistent with the collisionless theory disappear if the ion–ion collision probability within the diode plasma exceeds 0.1 per emitter distance. In the experiment the potential distributions are scanned using an electron beam probe technique. The results are consistent with theory. (auth)

5026 (IPP–3/97) CALCULATION OF THE GAS PARAMETER IN MHD GENERATORS. Zinko, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

The variation of the gas parameter in ideal MHD generators with infinite electrode segmentation can be described by simple analytic relations if the current density, load factor, and magnetic field are kept constant. The magnetoplasmadynamic equations derived under these conditions for three types of ducts (constant area, constant velocity, and constant Mach number) are applied by means of numerical computation to alkali rare gas mixtures with nonequilibrium conductivity. In this way the gas parameters such as pressure, temperature, density and velocity and electrical data such as current density, power density, and electrical conductivity can be plotted as functions of the duct length. The properties and efficiency of the various types of ducts are discussed and compared. As an example of application, the efficiency and magnetic field strength are calculated as functions of the load factor and Mach number for a MHD generator with a thermal power of 100 MW. In addition, various gas mixtures such as Ar–K, Ne–Cs, and He–Cs as well as pure argon are compared with one another in respect of their conductivity and power densities. (auth)

5027 (NP–18062) DEVELOPMENT OF THERMIONIC CONVERTERS. Quarterly Report No. 3. Jacobson, Dean (Electro-Optical Systems, Inc., Pasadena, Calif.). 15 Oct 1969. Contract 952255. 9p. (EOS–4018–Q–3).

For Jet Propulsion Lab., Pasadena, Calif.

The design and development of low-power, high-efficiency thermionic converters of cylindrical geometry are discussed. The converters will be capable of being integrated to form a modular power supply. The central philosophy of this approach is to increase the reliability of thermionic space power supplies by redundancy of the basic component. Seven converters and a bombardment heater unit are deliverable items. Performance data are reviewed separately, and will formulate the basis for redesign. (auth)

5028 RATE OF GROWTH OF ELECTROTHERMAL INSTABILITY AND CRITICAL HALL PARAMETER IN LINEAR GENERATORS WITH A CLOSED CYCLE WHEN THE ELECTRON MOBILITY IS VARIABLE. Petit, Jean-Pierre; Valensi, Jacques (Univ. d'Aix, Marseille). Compt. Rend., Ser. A; 269: 365-7(1 Sep 1969). (In French).

In the evolution of a real plasma from equilibrium, the conditions favorable to instability development can be found in a certain electron temperature interval, the crossing of which would only be possible if the ionization relaxation time is clearly smaller than the time characteristic of the instability development. Also, in this case, the Hall factor calculated assuming a homogeneous plasma, is less than β_{cr}. On the other hand, for $T_g = 3000°K$, the theory gives a positive growth. (J.F.P.)

5029 IMPROVEMENTS TO ELECTRODE ASSEMBLIES. Dubois, Andre (to Commissariat a l'Energie Atomique). British Patent 1,171,515. 19 Nov 1969. Priority date 16 Aug 1966, France.

This invention relates to electrode assemblies including ceramic materials enriched with emissive material as used in MHD generators and in particular to electrodes which use ceramic materials enriched with emissive materials. An electrode assembly for withstanding large temperature variations is described. (M.O.W.)

5030 FUNDAMENTAL PHENOMENON OF MAGNETOHYDRODYNAMIC ENERGY CONVERSION. Csorsz, E. (Matra Regional Metal Works, Sirok, Hungary). Acta Tech. Acad. Sci. Hung., 65: 43-56(June 30, 1969).

In this study of direct energy conversion in a direct-current magnetohydrodynamic generator using a quasi-neutral gas plasma as a working fluid, the relations governing plasma equilibrium are used. The density of the gasdynamic forces acting on various plasma components is discussed in a novel manner by employing the product of partial pressure gradients and momentum-transfer probabilities. Equations are given for calculating the power available at the output terminations and power density. Part of the dynamic gas power is not converted into electrical power, and this part returns to its initial state at the end of the conversion process; the Joule heat in a generator is therefore not an irreversible loss. (JPRS)

Fluid Physics

5031 (IPP–1/96) THE DYNAMIC STABILIZATION OF THE RAYLEIGH–TAYLOR INSTABILITY AND THE CORRESPONDING DYNAMIC EQUILIBRIUM. Wolf, G. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 16p. Dep. CFSTI (U. S. Sales Only).

Conditions are derived for dynamically stabilizing the Rayleigh–Taylor instability of a fluid interface and for attaining the corresponding dynamic equilibrium. These conditions could be proved in experiments using an aqueous solution of potassium iodide ($\rho_h = 1.6$ g/cm^3) as the heavy fluid and oil (viscosity SAE 140, $\rho_l = 0.9$ g/cm^3) as the light one. Parametric resonances were suppressed, but could be observed using oil of lower viscosity. (auth)

5032 EXPERIMENTAL STUDY OF A DRIVING MOTION, BY A MOVING WALL, OF AN ELECTROCONDUCTING LIQUID IN THE PRESENCE OF A MAGNETIC INDUCTION FIELD. Amy, Josette; Poirier, Yves; Vergnes, Jean (Faculte des Sciences de Luminy, Marseille). Compt. Rend., Ser. A; 269: 368-70 (1 Sep 1969). (In French).

An experimental study was made of the characteristics of the motion of an electroconducting liquid evolving in a very long-length duct, the rectangular section of which has a low height relative to its other dimension. It is assumed that one of two associated walls is moved at a constant velocity and that the other wall parallel to the preceding wall is kept fixed. The other two walls are very conducting, and are connected externally by a pure resistance. A uniform induction is applied parallel to the two conducting walls. (tr-auth)

5033 A NOTE ON MAGNETOHYDRODYNAMIC DUCT FLOW. Butler, G. F. (Royal Aircraft Establishment, Farnborough, Eng.). Proc. Cambridge Phil. Soc.; 66: 655-62(Nov 1969).

The problem of the flow of an incompressible electrically conducting fluid along a rectangular duct under a transverse magnetic field is discussed. The case in which the walls perpendicular to the field are perfectly conducting and those parallel to the field are non-conducting was considered by Hunt (J. Fluid Mech., 21: 577-90 (1965)) who derives the solution in two ways: as the limiting cases of the flows with (a) nonconducting walls parallel and thin walls of arbitrary conductivity perpendicular to the field, and (b) thin walls of arbitrary conductivity parallel and perfectly conducting walls perpendicular to the field. It is shown that these two limiting solutions derived by Hunt are in fact equivalent. In addition, the solution of case (b) is extended by removing the thin wall restriction. (auth) (UK)

5034 MAGNETOHYDRODYNAMIC STOKES FLOWS FOR ROTATING SOLIDS OF REVOLUTION. Ranger, K. B. (Univ. of Toronto). Proc. Cambridge Phil. Soc.; 66: 663-74(Nov 1969).

Consideration is given to the problem of magnetohydrodynamic Stokes flow for magnetized bodies of revolution rotating with steady motion in a viscous conducting fluid at rest at infinity. In all cases the magnetic field originates inside the body and is caused by a magnetic pole, magnetic dipole or a continuous distribution of poles located on the axis of symmetry. On the assumption that both the magnetic Reynolds number R_m and the Reynolds number R are small, convection is uniformly small and the flow equations reduce to a pair of coupled linear partial differential equations of the fourth order for the velocity and induced fields. The only component of the velocity field is perpendicular to the meridional plane, which is also the direction of the induced field. In certain cases, depending on the type of free magnetic field and the geometry of the boundary, the flow equations are reduced to a pair of coupled ordinary differential equations of the fourth order. For example, in the case of a magnetic pole located at the center of a conducting sphere, an exact solution of the flow equations is obtained in terms of elementary functions and is valid for arbitrary values of the Hartmann number M. The paraboloid of revolution, in which the free field is produced by a continuous distribution of magnetic poles of uniform density stretching from the focus to infinity, is another case where the flow equations can be solved in a simple finite form. For small values of M it is shown that for the case of a magnetic pole, and a magnetic dipole located at the center of a sphere, the net couple on the sphere is increased by a term of order M. (auth) (UK)

5035 SOLUTION OF ONE CLASS OF MAGNETOHYDRODYNAMIC PROBLEMS WITH STRENGTHENING OF THE MAGNETIC FIELD. Getling, A. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 187: 301-4(July 11, 1969). (In Russian).

A model of an oscillatory hydromagnetic dynamo is of interest in explaining the 11-year variations of the toroidal magnetic field of the Sun, where with cellular convection the material mass of the Sun is raised in the center of each cellular element, and then flows off to the sides. The deeper layers of the Sun are convectively stable, and because of the very small ohmic dissipation the magnetic field can hardly rearrange itself within an observable period of time. It would be expected that this convection is responsible for operation of the solar dynamo. In general, the dynamo would operate thus. The differential rotation of the Sun forms from the available weak meridional field a stronger azimuthal (toroidal) field. Each convective cell by winding the force lines of the toroidal field strengthens the field even more, and the action of the Coriolis forces leads to a turning of the whole picture around the axis of the cell. Diffusion of the magnetic field gradually smooths out the inhomogeneities, thanks to which a large-scale meridional field is generated with a sign opposite to the former field. After some time the meridional component of the total field changes its sign, and the whole process is repeated. The magnetic configuration of the hydromagnetic "activity" of such a cell is investigated in the presence of a Coriolis force. The problem is solved for the simplest model with a possible transition to handling more diverse situations. (TTT)

5036 MAGNETODINAMICA FLUIDELOR. (Magnetohydrodynamics). Dragos, Lazar. Bucuresti, Editura Academiei Republicii Socialiste Romania, 1969. 477p.

This book contains 10 chapters and is divided into two parts. The first part covers theory and equations for electromagnetic fields, microscopic theory, electrodynamics of continuous media, and Maxwell equations for media in motion. Nonrelativistic magnetofluiddynamics are described in the second part, considering equations of motion, laminar flow between parallel plates and pipes, theory of MHD generators, incompressible and compressible fluid flow past thin airfoils, viscous fluid flow past thin foils, propagation of conducting fluids, and shock-wave theory. 67 general references and separate references for each chapter are included. (R.V.J.)

5037 FLOW BEHIND MAGNETOGASDYNAMIC SHOCK WAVES. Gupta, R. S.; Upadhyaya, U. S. (Univ. of Allahabad, India). Tensor, 20: 153-7(May 1969).

Using the compatibility conditions of Thomas (J. Math. Mech., 6: 311-22(1957)), a technique is developed for the determination of the flow gradients and field parameters behind an oblique MGD shock in three-dimensional unsteady flow. The existence and uniqueness condition of the gradients behind the shock are obtained that are in full agreement with Ram (Tensor, N. S., 18: 323-9(1967)). Expressions for the vorticity and current density generated behind the shock wave are also presented. (L.M.T.)

5038 ALFVEN WAVE IN A RELATIVISTIC GAS. Nariboli, G. A. (Iowa State Univ., Ames). Tensor, 20: 161-6 (May 1969).

This study is based on the theory of singular surfaces. A singular surface Σ is defined as one across which at least some of the field variables or their derivatives suffer discontinuities. The field variables themselves are known to obey some partial differential (or integro-differential) equations characterizing the continuum. Here, given the discontinuities in the normal derivatives of the field variables, the partial derivatives do not remain arbitrary but have to obey certain inner consistency or compatibility conditions. These compatibility relations, in combination with the field equations, make possible study of the growth of various discontinuities across the moving surface Σ as it moves. These ideas are reviewed as applicable to special relativity. Based on Hadamard's lemma, the compatibility conditions are shown to be equivalent to the resolution of a vector into its components in a certain reference. Then, ideas of the ray theory are presented as are suitable for this study. Next, some general properties of the field equations of relativistic magnetogasdynamics are discussed. The results are applied to study the growth of Alfven wave. (TSS) (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 4516, 5012, and 5019.

5039 (AD-691744) ELECTRON PRECIPITATION PULSATIONS. Report No. R-48. Coroniti, F. V.; Kennel, C. F. (California Univ., Los Angeles. Plasma Physics Group). Apr 1969. Contracts Nonr-4756(01); AT(11-1)-34. 36p. CFSTI.

When high-frequency wave turbulence is present, low-frequency micropulsations can strongly modulate the high-frequency wave amplitudes, leading to finite-amplitude pulsations in the loss rate of energetic electrons from the magnetosphere. An extremely idealized model suggests that the precipitation modulation depends exponentially on the micropulsation amplitude, when the micropulsation period is less than the electron precipitation lifetime. (auth) (USGRDR)

5040 (AD-691745) AURORAL MICROPULSATION INSTABILITY. Report No. R-49. Coroniti, F. V.; Kennel, C. F. (California Univ., Los Angeles. Plasma Physics Group). May 1969. Contracts Nonr-4756(01); AT(11-1)-34. 50p. CFSTI.

A drift instability of Alfvén waves driven by the sharp electron thermal gradient at the inner edge of the electron plasma sheet is described. The analysis predicts a localized instability with wavelengths perpendicular to the magnetic field comparable with an ion cyclotron radius and parallel wavelengths comparable with the length of field lines. The fastest growing wave should have an approximate 10-second period, consistent with observations of Pi 1 micropulsations observed during substorms. (auth) (USGRDR)

5041 (AD-691831) VLF MEASUREMENTS OF THE POYNTING FLUX ALONG THE GEOMAGNETIC FIELD WITH THE INJUN 5 SATELLITE. Progress Report, April–June 1969. Mosier, Stephen R.; Gurnett, Donald A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jun 1969. Contracts Nonr-1509(06); NAS5-10625. 41p. CFSTI.

The direction of the Poynting flux, up or down the geomagnetic field, was determined for several types of vlf radio noise phenomena observed with the Injun 5 satellite, thereby providing information about the source region of these waves and their propagation in the ionosphere. Determinations of the Poynting flux direction of proton whistlers show that they are propagating up the geomagnetic field lines in accordance with the accepted theory of proton whistler propagation, thus providing a good check on the experimental technique. Initial measurements are presented on the Poynting flux, direction of the elf hiss, periodic emissions, vlf hiss, and chorus. Of particular interest is a new type of vlf emission called a saucer, which is found to be propagating upward from a source below the satellite. A qualitative explanation of the frequency-time shape of this new type of emission is presented. (auth) (USGRDR)

5042 (AD-691911) IONOSPHERIC RESEARCH USING SATELLITES. Final Scientific Report, December 1, 1964–January 31, 1969. Mass, Jonathan; Houminer, Zwi (National Committee for Space Research, Haifa (Israel). Radio Observatory). Feb. 28, 1969. Contract AF61(052)-837. 45p. (AFCRL-69-314). CFSTI.

Ionospheric electron content above Haifa was determined for the period of November 1964 to June 1966, from observations of the S-66 satellite. Diurnal and seasonal variations in electron content as well as solar and magnetic activity dependence are discussed. Some results are given concerning "slab thickness" and horizontal gradients in electron content. Amplitude recordings of the 136-MHz transmissions of the Canary Bird synchronous satellite were analyzed for scintillations for the period December 1967 to January 1968. Diurnal variations and probability distributions of amplitude scintillations for this period are presented. (auth) (USGRDR)

5043 (D-1-82-890(Rev.)) ELF PROPAGATION AND EMISSION IN THE MAGNETOSPHERE. Liemohn, H. B. (Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.). Aug 1969; Revised Oct 1969. 54p. (CONF-690823-1).

From International Union of Radio Science 16th General Assembly, Ottawa, Canada.

Considerable research progress has been achieved on elf signals in the magnetosphere as a consequence of satellite and ground-based studies. Attention is focused on the frequency band from 0.2 to 500 Hz, which is well below the minimum electron plasma and cyclotron frequencies, so that the hydromagnetic approximation applies. Although the magneto-ionic medium is anisotropic and inhomogeneous, the propagation theory for the fast and Alfvén modes in homogeneous media is adequate at these frequencies. The signal velocity of the fast mode is essentially isotropic for frequencies below the lower hybrid resonance. The Alfvén mode is restricted to frequencies below the proton cyclotron frequency and its signal velocity is closely guided by the geomagnetic field. The morphology of these modes in remote regions of the magnetosphere is being developed from satellite studies. Statistics are available now on the elf noise distributions with latitude, local time, and geomagnetic activity. Studies based on ground observations have concentrated on dispersion, polarization, and amplitude analyses. Due to ionospheric attenuation, ground observations of elf signals from the magnetosphere are limited to frequencies below about 10 Hz. In the band from 0.2 to 10 Hz, however, many types of geomagnetic micropulsation signals are observed. The characteristic dispersion of one class of signals led to its interpretation as Alfvén-mode waves which propagate back and forth along field-line paths. These "ulf whistlers" are sufficiently well documented to permit their use as magnetospheric probes of the thermal plasma distribution. Polarization studies have attempted to isolate the propagation modes, but coupling in the ionosphere has hampered progress. Signal amplification by the cyclotron-resonance interaction with energetic particles, and attenuation in the ionospheric waveguide have been extensively investigated theoretically. (auth)

5044 (LA-4253) RADIO FLASH ARISING FROM DIFFERENTIAL SCATTERING. Suydam, B. R. (Los Alamos Scientific Lab., N. Mex.). Aug. 1969. Contract W-7405-eng-36. 4p. Dep. CFSTI.

Owing to the atmospheric density gradient, scattered gamma-ray photons which arrive at a point distant from a nuclear burst have a distribution in the transverse direction which is not isotropic. This leads to a net Compton electron current in the θ-direction which in turn emits an electromagnetic signal. In this note this signal is estimated. (auth)

5045 (N-69-33375) VARIATION OF THE ION TEMPERATURE GRADIENT ALONG FIELD LINES IN THE OUTER PLASMASPHERE. Grebowsky, J. M.; Rahman, N. K. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1969. 14p. (NASA-TM-X-63618; X-621-69-225). CFSTI.

The equations of thermal diffusion are used to explore the variation of the ion temperature in the outer plasmasphere, where H^+ is the dominant positive ion. It is shown that the ion temperature gradient component in the direction of the magnetic field is a function of only the ratio of the H^+ scale height to the He^+ scale height along the field direction when either the ion and electron temperatures are equal or the scale-height ratio is unity. The ion temperature gradients are determined throughout the plasmasphere where the H^+/He^+ concentration ratio is assumed to be spatially invariant. At an altitude of 1000 km in the protonosphere, the magnitude of the computed upward directed ion temperature gradient component along the field line increases from 0.9°K/km near L = 1.3 to 1.5°K/km at L = 5. The computed ion temperature variations are in general agreement with electron temperature observations in the topside ionosphere and the outer plasmasphere. (auth) (STAR)

5046 (N-69-33441) SOME IONOSPHERIC PROPERTIES AT 1000 KILOMETERS ALTITUDE WITHIN THE AURORAL OVAL. Dyson, P. L.; Zmuda, A. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1969. 47p. (NASA-TM-X-63613; X-621-69-130). CFSTI.

Explorer 22 electrostatic probe measurements of electron density (N_e) and temperature (T_e) show that at 1000 km the ionosphere within and near the auroral oval is characterized by relatively large latitudinal variations in both N_e and T_e. Electron-density enhancements occur which vary from the order of ten kilometers to several hundred kilometers in horizontal extent. They vary in magnitude from increases of 10% upwards and the N enhancements are larger at night. Smaller scale variations ($\approx$ 1 km) also occur in N_e. The degree of correlation between T_e and N_e varies because of the dynamic nature of the phenomena occurring in the oval region. Simultaneous measurements of local magnetic field fluctuations in the oval show that often the ionosphere is most irregular in the region where the magnetic disturbances occur. It is likely that the magnetic disturbances are the result of field aligned currents but the direct ionospheric effects of such currents are too small to cause the changes observed in N_e and T_e. (auth) (STAR)

5047 (N-69-33574) ASTROPHYSICAL AND GEOPHYSICAL VARIATIONS IN ^{14}C PRODUCTION. Lingenfelter, Richard E.; Ramaty, Reuven (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1969. 47p. (NASA-TM-X-63615; X-611-69-300; CONF-690817-3). CFSTI.

From 12th Nobel Symposium on Radiocarbon Variations and Absolute Chronology, Uppsala, Sweden.

The production rate of ^{14}C was renormalized, based on new atmospheric neutron measurements and on cosmic-ray and ionization monitor records. The best calculation of production rate and decay of ^{14}C was obtained from ^{14}C variations determined from dendrochronology. Differential equations are presented for ^{14}C activity. It is shown that the major component of these variations can be understood in terms of measured geomagnetic fields. Shorter time variations may result from solar-modulated cosmic rays, solar flare particles, and possible supernova gamma rays, while longer-time variations may reflect change in cosmic-ray flux. (STAR)

5048 (N-69-34536) NEW MEASUREMENTS OF THE ABSOLUTE COSMIC-RAY IONIZATION FROM SEA LEVEL TO 1540 KILOMETERS ALTITUDE. George, Michael James (California Inst. of Tech., Pasadena). Apr. 25, 1969. Contracts NAS5-3095; NAS5-9317; NAS7-100; Nonr-220(53). 174p. (NASA-CR-104068). CFSTI.

Thesis.

The construction of an air-filled ionization chamber is described. This chamber was flown along with an older, argon-filled, balloon-type chamber in a C-135 aircraft from 1,000 to 40,000 feet altitude, and other measurements of sea-level cosmic-ray ionization were made. The calibrations of the two instruments were found to agree within 1%, and the airplane data were consistent with previous balloon measurements in the upper atmosphere. Ionization due to radon gas in the atmosphere was investigated. Absolute ionization data in the lower atmosphere were compared with results of other observers, and discrepancies are discussed. Also, data from a polar orbiting ion chamber on the OGO spacecraft were analyzed. The problem of radioactivity produced on the spacecraft during passes through high fluxes of trapped protons was investigated, and some corrections determined. (auth) (STAR)

5049 (N-69-34540) COMPARISON OF POST STORM NON-ADIABATIC RECOVERY OF TRAPPED PROTONS WITH RADIAL DIFFUSION. Soeraas, Finn (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1969. 24p. (NASA-TM-X-63625; X-612-69-241). CFSTI.

During magnetic storms it has been observed that the geomagnetically trapped protons undergo rapid nonadiabatic changes followed by slow nonadiabatic recovery approaching the pre-storm values. The slow nonadiabatic recovery can be accounted for in a semiquantitative way by solving a time-dependent Fokker–Planck equation with radial transport and loss terms describing Coulomb energy degradation and charge exchange. The equation is solved numerically in a region of space where measurements are available of the 100- to 1700-keV protons mirroring at the equator. (auth) (STAR)

5050 (N-69-34891) MAGNETOSPHERIC DUCT PROPAGATION RESEARCH USING ALOUETTE-2 TOPSIDE-SOUNDER OBSERVATIONS. Ramasastry, Jayaram; Walsh, Edward J. (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). Aug. 1969. 75p. (NASA-TN-D-5332). CFSTI.

The intense field-aligned propagation activity in the longitudes of Singapore observed by the Alouette-2 topside sounder are discussed. The frequency occurrence of sequences of ionograms containing conjugate echo traces is discussed in detail and attributed to the presence of field-aligned irregularities over a wide L-value range in the magnetosphere. Also described is the development of a unified model of field-aligned ducts in the magnetosphere from the analysis of the fine structure and diffuseness of the conjugate echo traces observed by the Alouette-2 sounder. The proposed model for the magnetospheric ducts is a large-scale, field-aligned, gaussian enhancement of electron density with a superimposed fine structure of small-scale gaussian ripples so that the large-scale variation has a ribbed rather than a smooth structure. Mathematical and digital ray-tracing analyses of the new model, along with illustrative ionograms used in postulating the model, are presented. (auth) (STAR)

5051 (N-69-35358) THE EVOLUTION OF AN ARTIFICIAL IONOSPHERIC PLASMA CLOUD AS STUDIED BY HF AND VHF RADAR. Davis, J. R.; Curley, S. R. (Naval Research Lab., Washington, D. C.). Apr. 3, 1969. 20p. (AD-688412; NRL-6865). CFSTI.

A plasma cloud was created at an altitude of 94 km over Wallops Island by exploding a canister of a cesium compound, which had been fired from a 7-in. gun. This cloud was illuminated from NRL, by hf and vhf radar. The results of coherent pulse Doppler analysis of the cesium cloud signature indicate that the cloud evolved in a billowy manner, with turbulent eddies of about 10,000 m^2 cross section appearing at several times within the nominal 70-sec duration of the signature. It was the presence of large-amplitude, specular echo components in the cloud signature that led to the suggested behavior of a cloud evolving in a billowy manner. The fact that these could be due instead to transient resonances in the plasma cloud cannot be completely discounted. (auth) (STAR)

5052 (N-69-35646) FULL-WAVE CALCULATION OF REFLECTION COEFFICIENTS FROM D-REGION ELECTRON-DENSITY PROFILES. Its Aeronomy Report No. 33. Viertel, W. A.; Sechrist, C. F. Jr. (Illinois Univ., Urbana. Aeronomy Lab.). Jan. 1, 1969. 73p. (NASA-CR-105425). CFSTI.

The reflection of vlf radio waves from the D region of the ionosphere is considered. In particular, the calculation of the reflection coefficient matrix below the ionosphere is described. Full-wave theory is employed in a FORTRAN 4 computer program for use with the IBM 360 computer. The program is checked by comparing computed reflection coefficients with those obtained by an analytical method for the case of a vertical geomagnetic field and an exponential electron density model, and also with full-wave computations done by other groups for a more general case. Suggestions are given for the application of the full-wave program to the computation of vlf reflection coefficients from D-region electron density profiles measured by ground-based and rocket techniques. (auth) (STAR)

5053 PHYSICS OF THE IONOSPHERE. Beynon, W. J. G. (Univ. Coll. of Wales, Aberystwyth). Sci. Progr. (Oxford), 57: 415-33(1969).

An outline description is given of some of the main features of the ionosphere. Topics briefly discussed include: experimental techniques, physical properties and chemical composition, regular and irregular variations, sporadic-E ionization, and horizontal movements, and the ionosphere in relation to other geographical phenomena. (auth) (UK)

5054 A COMPARISON OF IONOSPHERIC REFLECTION COEFFICIENTS CALCULATED WITH GENERALIZED AND NONGENERALIZED FULL-WAVE THEORY. Wand, I. C. (Univ. of Leicester, Eng.). J. Atmos. Terrest. Phys.: 31: 1233-9(Oct 1969).

Generalized and nongeneralized full-wave methods for the calculation of ionospheric reflection parameters were described by Deeks (1966a) and Pitteway (1965). In the former method the electrons are assumed to have a Maxwellian velocity distribution and allowance is made for the dependence of collisional frequency on electron velocity, whereas in the latter method the effective collisional frequency is assumed to be independent of velocity. A comparison is given of reflection coefficients calculated with the two full-wave methods for two typical ionospheric layers using related monoenergetic and effective collisional frequency profiles and frequencies in the range 10 to 100 kHz. Important differences are obtained and it is suggested that, in spite of the small increase in computer time, generalized theory should always be employed if reliable results are required. (auth) (UK)

5055 THE RELATION OF SUDDEN FREQUENCY DEVIATIONS TO THE SPECTRUM AND OTHER CHARACTERISTICS OF SOLAR MICROWAVE BURSTS. Strauss, Federico M. (Boston Univ.); Papagiannis, Michael D.; Aarons, Jules. J. Atmos. Terrest. Phys.; 31: 1241-59(Oct 1969).

Sudden Frequency Deviation (SFD) events were correlated with solar radio bursts observed at five different frequencies (606, 1415, 2695, 4995, and 8800 MHz). The best single frequency correlation was found at 4995 MHz. Using the spectral classification of AFCRL for microwave bursts, the highest correlation was obtained for bursts with a spectrum showing an intensity maximum in the observing frequency range (606 to 8800 MHz) and the lowest correlation for bursts with intensity spectra decreasing with frequency. The correlation increased with the intensity of the bursts for all spectral classes. The intensity distribution of the radio bursts and the SFD's were computed and both were found to follow approximately an inverse square law of the intensity. The agreement was again best at 4995 MHz. SFD's were also correlated with Sudden Cosmic Noise Absorption (SCNA) events, with which they were found to have only a weak correlation. (auth) (UK)

5056 COMPARISON OF AURORAL LIGHT EMISSION AND ELECTRON DENSITY. Jespersen, M. (Danish Space Research Inst., Lyngby); Landmark, B.; Maseide, K. J. Atmos. Terrest. Phys.; 31: 1251-7(Oct 1969).

Simultaneous measurements of the auroral light emission and the electron density were made during three rocket flights into auroral glow. The optical measurements were made on the (0–1) first negative band of N_2^+ at 4278 Å, and the volume emission rate vs. altitude was obtained. The electron density measurements were made by a propagation experiment based upon the Faraday rotation technique. From the observed emission rate of photons Q, the production rate of ion pairs q, is deduced, and assuming equilibrium conditions, the effective recombination coefficient α is derived as the ratio between q and the square of the electron density N. The recombination rates so derived are in fairly good agreement with laboratory measurements. (auth) (UK)

5057 N_2 VEGARD-KAPLAN BAND SYSTEM IN AURORA. ROTATIONAL TEMPERATURES AND VIBRATIONAL POPULATIONS. Ahmed, M. (Univ. of Saskatchewan, Saskatoon). J. Atmos. Terrest. Phys.; 31: 1259-71(Oct 1969).

The rotational structure of the Vegard–Kaplan bands of N_2 was successfully synthesized. The rotational temperatures of the Vegard–Kaplan bands of N_2 determined from the auroral spectra are in the range 900 to 2200°K. The close agreement between the N_2 Vegard–Kaplan temperatures and the N_2^+ first negative temperatures suggests rotational equilibrium in the $A^3\Sigma_u^+$ state. The variations in the relative populations of the vibrational levels of the $A^3\Sigma_u^+$ state are consistent with the cascading mechanism of Broadfoot and Hunten (1964). (auth) (UK)

5058 FEASIBILITY STUDY ON THE CALCULATION OF THE INTEGRAL CONTENT $\int$ N ds OF THE UPPER ATMOSPHERE AND A PROPOSAL FOR A NEW-STYLE BEACON EXPERIMENT IN ORDER TO DETERMINE $\int$ N ds FOR THE IONOSPHERE AND MAGNETOSPHERE UP TO 36,000 KM USING SIGNALS FROM GEOSTATIONARY SATELLITES. Dieminger, W.; Hartmann, G. K.; Schmidt, G. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). J. Atmos. Terrest. Phys.; 31: 1287-9(Oct. 1969).

By using the beacon frequencies of a geostationary satellite with frequency ranges >130 MHz it can be shown that above 5000 km the upper atmosphere does not contribute measurably to the Faraday rotation angle. This is due to the weighting of the Earth's magnetic field and the decrease in electron content with increasing altitude. The so-called differential Doppler is not affected by the above mentioned weighting function and therefore $\int N\,ds$ is measurable along the total range up to 36,000 km—the distance of the geostationary satellite. In order to measure the total electron content up to 36,000 km, a new method is proposed. (auth) (UK)

5059 SPATIAL DISTRIBUTION OF Pi2 MICROPULSATIONS. Jha, H. N.; Rosser, W. G. V. (Exeter Univ., Eng.). J. Atmos. Terrest. Phys.; 31: 1301-9(Nov 1969).

Investigations of Pi2 micropulsations show that very good correlations can be obtained over distances of about 1000 km in the north—south direction between geomagnetic latitudes of 62°30′N and 54°20′N, but much poorer correlations over distances of about 140 km. These differences over distances of about 140 km, which are particularly marked in the vertical component, may be associated with coastline or geological effects. (auth) (UK)

5060 ATMOSPHERIC PENETRATION OF ULTRAVIOLET AND VISIBLE SOLAR RADIATIONS DURING TWILIGHT PERIODS. Thomas, L.; Bowman, M. R. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 31: 1311-22(Nov 1969).

A numerical study was made of the penetration of solar radiations of wavelength 100 to 600 nm (1000 to 6000 Å) to heights below 100 km during the pre-sunrise period. Account was taken of absorption by molecular oxygen and ozone, Rayleigh scattering, and atmospheric refraction; the effects of changes in the height distribution of ozone are considered. The results of the computations are related to observations of the D region and of the airglow during the pre-sunrise period. The region of the solar spectrum responsible for the changes in D-region electron densities, indicated by vlf and lf radio measurements, is identified and the electron detachment processes discussed. The atmospheric penetration of radiations believed to be involved in the excitation of the infrared atmospheric band system of molecular oxygen is also considered. (auth) (UK)

5061 EXCITATION OF CHARACTERISTIC X RADIATION IN AN ATMOSPHERE. Tomlin, S. G. (Univ. of Adelaide). J. Atmos. Terrest. Phys.; 31: 1323-32(Nov 1969).

It is shown how the intensity of characteristic x radiation generated in an atmosphere could be calculated given sufficient information about the spatial and energy distribution of the irradiating electrons. In the absence of such data, detailed discussions of idealized models are presented. These provide a basis for forming a qualitative picture of the x-ray intensity distribution in the real atmosphere, and an estimate of the order of magnitude of the intensity. In an exponential nitrogen atmosphere the intensity reaches values of the order of 10^{-3} quanta cm^{-2} sec^{-1} for each electron incident normally per sec per cm^{2}. (auth) (UK)

5062 A NEW ANALYSIS OF ECLIPSE EFFECTS IN THE EQUATORIAL F REGION. Skinner, N. J. (Ahmadu Bello Univ., Zaria, Nigeria). J. Atmos. Terrest. Phys.; 31: 1333-44(Nov 1969).

F-region electron density measurements obtained during the solar eclipse of October 2, 1959, at Ibadan and Maiduguri are reexamined. A method was developed to analyze the data in which the transport term in the electron density continuity equation is retained, and its effect was found to be important. The variations of electron density at the two stations can be explained in terms of essentially the same ionospheric model in which there is downward vertical drift with velocities in the range 5 to 50 m sec^{-1} at the time of the eclipse, together with a vertical velocity gradient which decreases upwards. The values of the photoionization rate q and the linear loss coefficient β obtained from this analysis are consistent with those of other workers, and the scale heights of the atmospheric constituents predicted from the height variations of q and β are shown to imply reasonable exospheric temperatures. (auth) (UK)

5063 F2-REGION ACOUSTIC WAVES FROM SEVERE WEATHER. Baker, D. M.; Davies, K. (Earths Science Labs., Boulder, Colo). J. Atmos. Terrest. Phys.; 31: 1345-52(Nov 1969).

A certain type of wavelike ionospheric disturbance, characterized by periods in the range 2 to 5 min, is frequently observed during summer evenings over Kansas and Nebraska. These disturbances are apparently closely associated with severe local storms in the troposphere and are interpreted as manifestations of acoustic waves generated by the storms. (auth) (UK)

5064 DEVELOPMENT OF IONOSPHERIC ABSORPTION ASSOCIATED WITH STRATOSPHERIC WARMINGS IN 1958 AND 1963. Sinno, K.; Higashimura, M. (Radio Research Labs., Tokyo). J. Atmos. Terrest. Phys.; 31: 1353-7(Nov 1969).

The development of ionospheric absorption associated with major stratospheric sudden warmings which occurred in January 1958 and 1963 was investigated using the ionospheric parameter f_{min}. This morphological study, and certain other results concerning stratospheric warmings and anomalous winter absorption, suggest a mechanism for the possible interaction between these phenomena. (auth) (UK)

5065 SEASONAL EFFECT IN THE MID-LATITUDE SLAB THICKNESS VARIATIONS DURING MAGNETIC DISTURBANCES. Mendillo, M. (Boston Univ.); Papagiannis, M. D.; Klobuchar, J. A. J. Atmos. Terrest. Phys.; 31: 1359-64(Nov 1969).

By monitoring the vhf signals from geostationary satellites it was possible to study the diurnal changes in total electron content during individual magnetic storms. The June 15, 1965 and February 10, 1968 storms were studied in detail for possible seasonal effects in the variations of the slab thickness $\tau = N_T/N_{max}$ during magnetic storms. On the day of the storm τ was considerably above normal in both cases. During the second and third days after sudden commencement, however, the slab thickness was below normal for the winter storm but remained above average for the summer storm. This was probably due to changes in temperature, caused by the storm, affecting the recombination rate at different ionospheric altitudes. Possible seasonal causes of an observed midnight minimum in τ are also discussed. (auth) (UK)

5066 ROLE OF POST-BREAKUP PULSATING AURORA IN CONJUGATE POINT ABSORPTION INCREASES. Hajkowicz, L. A. (Univ. of Melbourne). J. Atmos. Terrest. Phys.; 31: 1365-70(Nov 1969).

On the basis of the available yearly riometer, photometer, magnetometer, and all-sky camera records from Macquarie Island and the northern conjugate area it is evident that the typical development of auroral substorms is similar at the auroral-zone conjugate stations. Simultaneous occurrence of arcs and bands precedes the breakup phase, which is followed by patchy, pulsating auroras, predominantly recorded in the morning hours at Kotzebue and Macquarie Island. The post-breakup phase is associated with strong absorption increases at both conjugate stations. It is suggested that the presence of certain daytime morning absorption bays is caused by hard electron precipitation associated with pulsating patches, recorded at the conjugate station in the night-time sector of the Earth. (auth) (UK)

5067 WHISTLER PROPAGATION IN A BOUNDED MAGNETOPLASMA. Lee, J. C. (Stanford Univ., Calif.). Int. J. Electron.; 26: 537-52(Jun 1969).

A paradox was pointed out by Wieder (1964) for whistlers in bounded magnetoplasmas. His work shows that, below half the electron cyclotron frequency, the wave propagation characteristics do not approach those of plane wave solutions in unbounded magnetoplasma, even when the plasma density is increased so that the wavelength is arbitrarily small compared to the plasma transverse dimensions. This apparent paradox is shown to result from the double reflection property of magnetoplasmas. Propagation characteristics in bounded plasma are related to the unbounded case by considering plane waves doubly reflected at the plasma boundary. As a by-product, limitations for the validity of the quasi-static approximation for body waves in bounded magnetoplasmas were established. (auth) (UK)

5068 WAVE—PARTICLE INTERACTION AROUND THE LOWER HYBRID RESONANCE. Horita, Robert Eiji. Vancouver, B. C.; Univ. of British Columbia (1968).
Thesis.

Wave—particle interaction in the ionosphere is studied theoretically for wave frequencies around the lower hybrid resonance (LHR) frequency. Expressions are derived by two methods for the growth rate of whistler-mode waves propagating in a magnetoactive plasma penetrated by a tenuous beam of nonthermal particles. The first method employs the electrostatic dispersion equation; the second uses the full-wave dispersion equation which reduces the electrostatic one for large values of refractive index. The equilibrium distribution function for the plasma is Maxwellian, and that for the diffuse streaming particles is also Maxwellian, but is shifted by a streaming velocity parallel to the background magnetic field. The first method assumes that the temperatures are isotropic, while the second assumes that the distributions are characterized by the perpendicular and parallel temperatures, $T_\perp$ and $T_{||}$. The growth-rate expressions are fairly general, but numerical calculations are performed for the case of a cold plasma consisting of electrons, H^+, He^+, and O^+ ions and a beam of nonthermal electrons. The theory presented is applied to LHR noise bands discovered by the Canadian Alouette I satellite. It is shown that many features are in good agreement. Other observations, such as auroral hiss, also have features which suggest that the theoretical work may be relevant to these types of ionospheric noise. (TCC) (Diss. Abstr.)

5069 RELATION BETWEEN RADIOEMISSION RECORDED BY "ELEKTRON" SATELLITES AND GEOMAGNETIC ACTIVITY. Benediktov, E. A.; Getmantsev, G. G.; Mityakov, N. A.; Rapoport, V. O.; Tarasov, A. F. Kosm. Issled., 6: 946-9(Nov.-Dec. 1968). (In Russian).

Sporadic radio emissions at 0.725 to 2.3 MHz were recorded by the instruments installed in satellites Elektron-2 and Elektron-4. The cosmic-background radio emission was recorded simultaneously at two frequencies, 0.725 and 1.5 MHz, for Elektron-2 and 1.1 and 2.3 MHz by Elektron-4. Sporadic radio emission was observed at all frequencies. However, there was no correlation between different events observed. Sporadic emission with a slow rise and sharp drop was observed only at 1.1 MHz. Sporadic radio emission at 0.725 and 1.5 MHz exhibited a characteristic latitudinal course with a minimum at the geomagnetic equator. A specific relation was found between sporadic emission and soft electron flux ($E > 100$ eV). Studies of the measurements made by Elektron-4 did not reveal any relation between the intensity of the sporadic radio emission and the latitude. The dependence of sporadic radio emission on soft electron flux exhibited a different character as compared to that of Elektron-2. Considering that the sporadic radio emission is induced by the fast charged-particle fluxes then the difference between the night and day structure of the magnetosphere results in the differences observed. The results confirmed the relation between sporadic radio emission and geomagnetic perturbations and its dependence on the position of the satellite in the magnetosphere. (R.V.J.)

5070 DETERMINATION OF THE VERTICAL PROFILE OF THE IONOSPHERE FROM THE MEASUREMENT OF THE TOTAL ELECTRON CONTENT. Bertin, Francois; Papet-Lepine, Jacques (Laboratoire de Physique de l'Atmosphere, Paris). Compt. Rend., Ser. B, 269: 149-52(July 21, 1969). (In French).

The radioelectric monitor of polar-traversing satellite beacons permits, under certain conditions, total electron content measurement, from which the vertical distribution can be deduced. (tr-auth)

5071 SHAPE OF THE PLASMAPAUSE IN PRESENCE OF SUBSONIC CONVECTIVE FLOW IN THE MAGNETOSPHERE. Samokhin, M. V. Kosm. Issled., 7: 611-13(July-Aug. 1969). (In Russian).

Results of this mathematical analysis showed that, because of lack of reliable experimental data on the plasma density and temperature in the magnetotail, it was impossible to evaluate the characteristic scale of a constant distance from the axis and the dimensions of the plasmopause. (R.V.J.)

5072 SEARCH FOR THE EFFECT OF STELLAR X-RAYS ON THE NIGHT-TIME LOWER IONOSPHERE. Burgess, B. (Royal Aircraft Establishment, Farnborough, Eng.); Jones, T. B. Nature (London); 224: 680-1(15 Nov 1969).

Vlf propagation data were examined for x-ray star effects, and possible enhancements of the night-time ionosphere by the major x-ray sources (galactic background, Sco XR-1, Crab Nebula, and Cyg XR-1) were computed in order to determine if the additional ionization produced is sufficient to allow detection by vlf propagation experiments. Conclusions reached were as follows: (1) the main source of night-time ionization above 85 km is scattered Lyman-α radiation; (2) the strongest x-ray source (Sco XR-1) produces approximately the same electron density distribution with height as the background x-ray flux; and (3) the x-ray sources can make a significant contribution below 85 km although the ionization produced by cosmic rays can dominate at these levels. It appears just possible that the x-ray sources could give rise to significant changes in the reflection levels of vlf waves propagated over long paths under night-time conditions. A very strong correlation between decrease in phase delay with time of year was confirmed. There appeared to be no dependence on sidereal time. (UK)

5073 STUDIES OF PROTON SPECTRA IN INTERNAL RADIATION BELT CARRIED OUT IN SATELLITE COSMOS-137. Savenko, I. A.; Savun, O. I.; Shavrin, P. I Kosm. Issled., 7: 553-8(July-Aug. 1969). (In Russian).

Data were obtained on proton spectra in the internal belt of the shell with $\alpha = 1.2$ to 1.7 and on the spatial distribution of protons in the plane of the geomagnetic equator at energies from 0.8 to 1000 MeV. Data obtained with satellite Cosmos-137 are correlated with earlier published data. (tr-auth)

5074 SCATTERING OF RADIO WAVES ON THE TRACK OF A BODY MOVING IN THE IONOSPHERE. Vas'kov, V. V. Kosm. Issled., 7: 559-68(July-Aug. 1969). (In Russian).

Cross sections for radio-wave scattering on the wake of a fast moving body in the ionosphere were calculated in the vicinity of maximum cross sections, using previously obtained asymptotic formulas. With the main maxima in which the difference of the wave vectors of the scattered and incident radio waves were perpendicular to the plane formed by the magnetic field with the body velocity vector and the wave frequency near to the plasma, the maximum of electron concentration in the F2 layer, the cross sections were found to be of the order of 10 to 20 m^2 with a body radius of 1 m. (tr-auth)

5075 ROLE OF L_α RADIATION IN LOWER IONOSPHERE IONIZATION. Tulinov, V. F. Kosm. Issled., 7: 575-9(July-Aug. 1969). (In Russian).

The altitude, latitude, and transient functions for the total rate of ion formation induced by corpuscular and solar (L_α and x ray) radiation were correlated with the corresponding functions for charged-particle concentrations in the lower ionosphere. It was found that with certain assumptions about the contributions of L_α emission at various elevations a definite correlation exists between the available data on the distribution of charged-particle concentrations and the sources of ionization. (tr-auth)

5076 EFFECTS OF AMERICAN STARFISH EXPLOSION ON THE CONDITION OF IONOSPHERE OBSERVED BY CENTRAL KAZAKHSTAN STATION. Erokhin, Yu. G.; Larionenko, O. I. Kosm. Issled., 7: 580-3(July-Aug. 1969). (In Russian).

Effects of the high-power explosion (TNT equivalent to 1.4 Mt) at 400 km over Johnston Island on 7-9-62, induced ionospheric perturbations recorded by world ionospheric stations. Data are given on perturbations recorded by the Central Kazakhstan Station and an analysis is given of the high-frequency characteristics taken a few days before the explosion, the day of the explosion, and after the explosion. (tr-auth)

5077 REDUCTION OF ELECTRON DENSITY IN THE F2 REGION FOLLOWING AMERICAN HIGH-ALTITUDE EXPLOSION July 9, 1962. Kozlov, S. I. Kosm. Issled., 7: 584-91(July-Aug. 1969). (In Russian).

Various aspects of the possible existence of heating (up to $\sim 10^4$ °K) of electron gas by primary photoelectrons produced during air absorption of the soft x radiation during the explosion are analyzed. It is concluded that the heating, except for the area directly adjacent to the point of explosion is, in principle, impossible. However, the acceleration of the ion-molecule reaction $N + O^+ \to NO^+ + N$ and, as a result of it, electron density in the F2 region could be reduced below normal in the cold ionosphere, even when subjected to the effects of the soft x radiation from the high-altitude explosion. (tr-auth)

5078 UNIFORM STRATIFIED LAYERS IN THE EQUATORIAL E REGION. Rao, U. R.; Degaonkar, S. S.; Banshidar; Patel, R. M. (Physical Research Lab., Ahmedabad, India). Nature (London): 224: 676-7(15 Nov 1969).

Some interesting electron density observations in the E region are described; the observations were made on a Centaure rocket, carrying a high-frequency capacitance probe, launched from the Thumba Equatorial Rocket Launching Station (8°32′N, 76°51′E) at 1530 IST on Feb. 26, 1969. Variation of the frequency of the component 5MHz oscillator is shown plotted against time from liftoff. The frequency showed no appreciable change for the first 85 sec, corresponding to an altitude of about 80 km, but as the rocket penetrated the E layer the frequency increased sharply and reached a maximum at about 115 sec, corresponding to about 110 km. Beyond this maximum the presence of long-period variations was evident. Also shown plotted is the electron density as a function of altitude; interesting features are the sharp increase in electron density beyond the peak, indicating a valley in the ionization, and a wavelike structure having a vertical wavelength of about 8 km. A similar picture was obtained with the 10-MHz oscillator. Although vertical stratification of the E-region ionization had been previously noted at middle latitudes, the presence of stratified layers with a remarkably uniform spacing of about 8 km between 120 and 140 km in the equatorial ionosphere is reported for the first time. Of many interpretations a physical mechanism based on internal atmospheric gravity waves appears the most attractive. Gravity-wave oscillations induce density variations in the neutral atmosphere which, in turn, give rise to variations in the ionization density, with successive maxima separated by a wavelength. The observation of about 8 km for the wavelength at 120 to 140 km, although consistent with theory, is slightly lower than expected from the gravity-wave mechanism; this discrepancy could be due to a difference between the value of the kinematic viscosity at middle and low latitudes, or to a possible modification of the electron density by the equatorial electrojet. (UK)

5079 VARIATION OF CORPUSCULAR RADIATION INTENSITY IN THE UPPER ATMOSPHERE AT MEAN LATITUDES.

Tulinov, V. F.; Moiseev, Yu. N.; Shapiro, I. G. Kosm. Issled., 7: 613-15(July-Aug. 1969). (In Russian).

The ionizing radiation intensity during a strong geomagnetic storm was measured by means of a rocket with a Geiger Counter on July 10, 1968, at 6 o'clock (near Volgograd). Two parallel front window counters were used for recording particles at angles 0 to 45° at various elevations. It was found that corpuscular and Lyman-α emissions are the main ionization sources. The curves for ionization rate at various elevations were constructed and the ratios for upper and lower maxima were obtained. The recorded increased intensity of corpuscular fluxes resulted in an increased (1.4 to 2.2 times) absorption of radio waves in the lower ionosphere. Thus, it was shown that at medium latitudes the influence of corpuscular radiation exerts a significant influence on the radio-wave absorption in the lower ionosphere. (R.V.J.)

5080 OBSERVATIONS OF THE GEOMAGNETIC TAIL AT 500 EARTH RADII BY PIONEER 8. Mariani, F. (Univ., Rome); Ness, N. F. J. Geophys. Res.; 74: 5633-41(1 Nov 1969).

In January 1968, Pioneer 8 passed through the extended geomagnetic tail region at 470 to 580 R_E. The magnetic field observations suggest detection of the geomagnetic tail; the observations are similar in characteristics to those observed by Pioneer 7 at 1000 R_E, but they indicate a higher percentage of time was spent in the region of an extended, aberrated tail. (auth)

5081 SHAPE OF THE TILTED MAGNETOPAUSE. Olson, W. P. (Univ. of California, Los Angeles). J. Geophys. Res.; 74: 5642-51(1 Nov 1969).

A model for the determination of the shape of the magnetopause is developed that permits the inclusion of cases where the solar wind is directed obliquely toward the geomagnetic dipole axis. The solar wind is assumed to have no motions perpendicular to its (constant) velocity vector (zero temperature approximation) and to be free of magnetic fields. The region within the magnetopause is characterized as having only one magnetic source and as being free of plasma. The procedure used here is in many ways similar to the self-consistent field method developed by Mead and Beard to calculate the shape of the magnetopause when the solar-wind flow is perpendicular to the dipole axis. They were able to find the surface shape (for perpendicular incidence) at one point at a time. In this study, however, it was necessary to determine the position of the surface at several points at a time. The geocentric distance to the subsolar point is found to be largest for perpendicular incidence of the solar wind on the dipole axis. The cross sections of the tail of the magnetopause given by the model are not cylindrical but elongated in the direction perpendicular to the ecliptic plane. Generally, the boundary is very dependent upon the wind–dipole angle in the region of the neutral points but exhibits very little dependence on this angle in "equatorial" regions. (auth)

5082 AN INVESTIGATION OF QUASI-PERIODIC VLF EMISSIONS. Kitamura, T. (Univ. of British Columbia, Vancouver); Jacobs, J. A.; Watanabe, t.; Flint, R. B. Jr. J. Geophys. Res.; 74: 5652-64(1 Nov 1969).

Quasi-periodic vlf emissions (QP's) observed at Eights, Byrd, and Polar Plateau Stations in Antarctica have been investigated. Periods of most QP's range from about 10 sec to about 2 min. At each of the stations QP's were generally found when the observing station was on the daylight side of the Earth. Two general types of QP's can be identified on the basis of spectral structure and associated geomagnetic micropulsation (GP) activity. One type, which is characterized by an emission frequency that increases without interruption during one quasi-period, lacks association with GP activity. When this type of QP occurs, either there is no concurrent GP activity or the QP period is entirely different from that of the accompanying GP. The vlf emissions may be either diffuse or discrete or a combination of both. The period often varies with the average vlf signal strength, becoming longer for weaker emissions. The second type of QP exhibits an association with GP activity. The upper frequency limit of the emission band often fluctuates in synchronism with changes in the signal strength. This type of QP has a diffuse spectral structure and is referred to here as low-frequency hiss. Such QP's often occur simultaneously with chorus and/or periodic emissions that may or may not show QP variations. Quasi-periodic low frequency hiss associated with geomagnetic micropulsations does not generally occur simultaneously at a pair of magneto-conjugate stations. QP's of the second type have lower emission frequencies (0.3 to 1.5 kHz) than the first type (1.5 to 6 kHz). (auth)

5083 CONJUGATE ECHOES OBSERVED BY ALOUETTE 2 TOPSIDE SOUNDER AT THE LONGITUDES OF SINGAPORE. Ramasastry, Jayaram; Walsh, E. J. (Electronics Research Center, Cambridge, Mass.). J. Geophys. Res.; 74: 5665-74 (1 Nov 1969).

This paper reports the high rate of occurrence of conjugate echoes observed by the Alouette 2 topside-sounder at the longitudes of Singapore during the year 1966. The ionograms containing conjugate echoes observed at Singapore and other equatorial and midlatitude stations are mostly in the form of sequences. Some sequences last as long as the corresponding soundings. Occurrence of such sequences may be attributed to the presence of field-aligned irregularities over a wide range of L values in the magnetosphere. However, the sounding times are, quite often, not long enough to observe fully the extent of the magnetosphere over which the field-aligned irregularities exist. No obvious correlation between the occurrence rate of conjugate echoes and the magnetic Kp index was found. (auth)

5084 VLF MEASUREMENTS OF THE POYNTING FLUX ALONG THE GEOMAGNETIC FIELD WITH THE INJUN 5 SATELLITE. Mosier, Stephen R.; Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 74: 5675-87(1 Nov 1969).

The direction of the Poynting flux, up or down the geomagnetic field, was determined for several types of vlf radio-noise phenomena observed with the Injun 5 satellite, thereby providing information about the source region of these waves and their propagation in the ionosphere. Determinations of the Poynting flux direction of proton whistlers show that they are propagating up the geomagnetic field lines in accordance with the accepted theory of proton whistler propagation, thus providing a good check on the experimental technique. Initial measurements are presented on the Poynting flux direction of elf hiss, periodic emissions, vlf hiss, and chorus. Of particular interest is a new type of vlf emission called a saucer, which is found to be propagating upward from a source below the satellite. A qualitative explanation of the frequency-time shape of this new type of emission is presented. (auth)

5085 EVIDENCE FOR REVERSIBLE HEATING IN THE E REGION FROM RADAR THOMSON SCATTER OBSERVATIONS OF ION TEMPERATURE. Wand, R. H. (Cornell Univ., Ithaca, N. Y.). J. Geophys. Res.; 74: 5688-96(1 Nov 1969).

Values of ion temperature (T_i) and ion–neutral collision frequency (v) in the daytime E region have been obtained from radar Thomson scatter measurements at the Arecibo Ionospheric Observatory. These quantities were deduced from the shape of the autocorrelation function of the backscattered signal that was measured with a height resolution of 15 km using a double-pulse technique. Usually the daily variation of T_i at 115 and 130 km exhibited wave-like structure that must also have been present in the neutral atmosphere because the ion and neutral constituents have the same temperature at these altitudes. The observed temperature oscillations are interpreted as a manifestation of the reversible adiabatic heating accompanying long-period internal gravity waves in the neutral atmosphere. A simple harmonic analysis of the temperatures for a number of days gives dominant wave periods of from 7 to 13 hours and fractional amplitudes as large as 22%. On the reversible heating explanation, the observed amplitudes of the temperature waves imply average horizontal wind amplitudes of 60 to 70 m/sec. A downward phase progression (corresponding to upward energy propagation) is evident with an average vertical wavelength near 60 km. A significant wave-like variation is also detected in some of the ion-neutral collision frequency results at 115 km. The period is similar to that of the corresponding temperature wave, but the fractional amplitude is larger, and there is an appreciable phase difference. The phase and amplitude of the variation in the neutral concentration, as predicted from the collision frequency variation using the polarization ion-neutral interaction, does not agree with that deduced from the temperature variation using simple internal gravity wave theory with upward energy propagation. The resolution of this discrepancy may depend on the removal of some of the idealizations in the gravity wave theory or the inclusion of additional ion–neutral interaction terms. (auth)

5086 LARGE TEMPORAL VARIATIONS OF ENERGETIC ELECTRON INTENSITIES AT MIDLATITUDES IN THE OUTER RADIATION ZONE. Yeager, D. M.; Frank, L. A. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 74: 5697-5708(1 Nov 1969).

A thorough search of Explorers 12 and 14 observations of electron (40 keV $\lesssim$ E $\lesssim$ 2 MeV) intensities within the outer radiation zone during the period 1961–1963 has provided evidences of several catastrophic rapid decreases and recoveries of these electron intensities within periods ~several minutes at L values ~5 to 6. Typical values for these intensity fluctuations are by factors $\gtrsim$500, $\gtrsim$100, and $\gtrsim$1000 for electrons E > 40 keV, 230 keV, and 1.6 MeV, respectively. A comparison of the temporal variations of integral energy spectrums of electron intensities, latitudes of the observed events, ground-based observations of auroral magnetic activity, and low-altitude measurements of electron intensities within the above energy range allows this striking phenomenon to be interpreted in terms of redistribution of these outer-zone electrons during the distortion of the geomagnetic field by the low-energy plasma producing the associated magnetic disturbance and of conservation of the first two adiabatic invariants μ and I. The principal features of these events are adequately accounted for with the above interpretation, as the signature of the motion of the "trapping boundary" for energetic electrons at midlatitudes in the dark hemisphere of the magnetosphere, which eliminates the alternative assumption of an almost unreasonably strong acceleration mechanism for outer-zone energetic electrons. (auth)

5087 DRIFT-DISSIPATIVE PLASMA INSTABILITY AND EQUATORIAL SPREAD F. Cunnold, D. M. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Geophys. Res.; 74: 5709-20(1 Nov 1969).

Electrostatic oscillations of a plasma drifting across a magnetic field are considered. The convective instability that arises in a medium containing a gradient of electron concentration is investigated for the case when charged-particle motions are dominated by collisions. The proposal that this instability is the amplification mechanism for producing the irregularities responsible for ionospheric spread-F conditions at equatorial latitudes is examined. It is proposed that irregularities that originate in the 130-km region of the nocturnal ionosphere and travel at essentially the electron drift velocity may be substantially amplified by this mechanism. They may appear as irregularities at F-region altitudes. An estimate is made of the maximum-amplification factor with the result that amplification by several orders of magnitude is possible. (auth)

5088 TRAVELING IONOSPHERIC DISTURBANCES ORIGINATING IN THE AURORAL OVAL DURING POLAR SUBSTORMS. Davis, M. J.; da Rosa, A. V. (Stanford Univ., Calif). J. Geophys. Res.; 74: 5721-35(1 Nov 1969).

A study of large-scale traveling ionospheric disturbances was carried out by investigating the signatures they leave in columnar electron content records. Columnar content was obtained at a number of widely spaced stations by measuring the Faraday rotation angle of a signal from a geostationary satellite. The results of observations from February 1967 to November 1968 are presented. A simple model relating variations in electron concentration produced by the passage of atmospheric gravity waves to changes in columnar content is developed. Using this model the observed fluctuations in columnar content are shown to be consistent with the effects expected to be produced by neutral atmospheric waves. Virtually all fluctuations studied occurred during magnetically disturbed periods with a tendency for more frequent occurrence near the middle of magnetic storms. A good correlation between the relative amplitudes of the disturbances, defined as the rms amplitude of the perturbations in electron content divided by the unperturbed content, and Kp is shown to exist. The disturbances exhibit a diurnal variation in speed and direction of travel. The speed variation is not completely explained. The average variation in direction of travel is consistent with a source located near dipole latitude 78°N and 1900 geomagnetic time. It is suggested that the disturbances originate in the auroral oval during polar substorms. (auth)

5089 D-REGION ELECTRON CONCENTRATION PROFILE PRODUCED BY THE JULY 9, 1962, NUCLEAR DETONATION. Jusick, A. T.; Furman, D. R. (Stetson Univ., DeLand, Fla.). J. Geophys. Res.; 74: 5737-42(1 Nov 1969).

Three possible D-region electron concentration profiles resulting from the July 9, 1962, "Starfish" nuclear detonation are derived, using multiple frequency measurements of the absorption of cosmic radio noise. Two methods of profile determination are used. The first method uses both the classical magnetoionic theory of Appleton and the generalized magnetoionic theory of Sen and Wyler. The second method uses only the classical theory of Appleton. The electron concentration height profiles obtained by the use of the two methods are then compared. The three profiles are found to differ by a maximum of 50% over the main absorbing region, which is centered about 60 km. A possible future application to the derivation of profiles produced by certain types of sudden ionospheric disturbances is discussed. (auth)

5090 WATER VAPOR ION CLUSTER CONCENTRATIONS IN THE D REGION. Ferguson, E. E.; Fehsenfeld, F. C. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 74: 5743-51(1 Nov 1969).

Utilizing some recently obtained laboratory rate constants of Good, Durden, and Kebarle, the qualitative water cluster ion production scheme proposed earlier has been made quantitative, although not precise. Despite large uncertainties involved in the calculations, several interesting conclusions can be drawn and some useful guidelines for further ionospheric and laboratory investigations established. The calculated concentration of $H_5O_2^+$ at the concentration maximum near 80 km agrees well with the observed values of Narcisi and Bailey. The values at 65 km do not agree well, which suggests that the reported values are too large due to difficulties in relating observed ion currents to ion concentrations. The calculations suggest the possibility that the water concentration decreases more rapidly above the mesopause than current model atmospheres predict, in order to account for the sharp decrease in observed water cluster ions above 82 km. (auth)

5091 SOME WINTER CHARACTERISTICS OF THE NORTHERN HIGH-LATITUDE IONOSPHERE. Miller, N. J.; Brace, L. H. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 74: 5752-62(1 Nov 1969).

Langmuir probe measurements of the winter diurnal behavior of the electron density (N_e) and temperature (T_e) at 1000 km at high latitudes are presented. The data are represented by contour plots of N_e and T_e on a grid of geomagnetic latitude and local time. The time period studied is November 1, 1965, through February 12, 1966. The N_e distribution is characterized by a zonal structure where the auroral oval is the transition region between the midlatitude and polar zones. N_e in the midlatitude zone exhibits a quasi-steady state through most of the night, and both N_e and T_e increase in value to an afternoon maximum. N_e in the dark polar zone decays until midnight after which the ionization increases toward a daytime level. The transition region, represented by the oval, shows enhancements in N_e suggestive of particle flux sources. In general, the dayside T_e contours do not correlate with the N_e contours. Limited comparisons between winter and summer indicate strong seasonal effects in the N_e pattern and unusually large values of T_e in the winter midlatitude zone. Characteristic troughs in N_e appear on the nightside for both seasons. Possible ionization sources that would be consistent with the observed ionization patterns are considered. (auth)

5092 EFFECTS OF SECONDARY ELECTRON EMISSION ON ELECTRON TRAP MEASUREMENTS IN THE MAGNETOSPHERE AND SOLAR WIND. Whipple, Elden C. Jr. (ESSA Research Labs., Boulder, Colo.); Parker, Lee W. J. Geophys. Res.; 74: 5763-74(1 Nov 1969).

The theory developed earlier for the behavior of an electron trap mounted on a charged spacecraft is extended to include the contributions of secondary electrons emitted from the spacecraft surfaces. Analytic formulas are derived that reproduce the results of particle trajectory calculations for all probe and satellite potentials, in the limit of large Debye length and no magnetic field. The analysis is complicated by the possible presence of a potential barrier for a repulsive satellite, and also by the presence of more than one emitting surface. It is shown, in solar-wind measurements where both "hot" and "cold" electron components are sometimes inferred, that while the "hot" component may be correctly attributed to the plasma, the "cold" component can at times be attributed to secondaries from the spacecraft surfaces. Incorrect interpretation of the observed currents has led in the past to overestimates of the electron concentration. A correct interpretation leads to electron concentrations in good agreement with positive-ion densities measured by other techniques in the solar wind. Measurements of electron concentration and temperature in the magnetosphere and in the solar wind should be viewed critically whenever the inferred temperature is in the range of characteristic secondary electron energies, i.e., a few electron volts. (auth)

5093 HYDROMAGNETIC EFFECTS ON ATMOSPHERIC TIDES. Taffe, William J. (Univ. of Chicago). J. Geophys. Res.; 74: 5775-91(1 Nov 1969).

To gain a better understanding of atmospheric tides at ionospheric levels, simple models are employed that exhibit the effects of hydromagnetic forces existent in the ionosphere acting on a hydrodynamic wave of tidal period. The presence of Hall conductivity, predominant in the lower E region, can cause the vertical wavelength to be shorter than hydrodynamic theory predicts. It also can cause a backing of the horizontal-wind velocity vector in the northern hemisphere and a veering in the southern hemisphere. The presence of Pedersen conductivity can cause the wave to be longer than a hydrodynamic mode wave, if the Hall conductivity is sufficiently small, and can also cause severe damping of the wave. Moreover, hydromagnetic effects allow the existence of two wave modes, in addition to the modified-hydrodynamic mode. One of these modes, if excited, can "map up" electric and velocity fields well into the magnetosphere. The model, however, does not allow an accurate description of the additional modes. These theoretical results are compared with observations of atmospheric tides in the ionosphere. (auth)

5094 DRIFT MIRROR INSTABILITY IN THE MAGNETOSPHERE: PARTICLE AND FIELD OSCILLATIONS AND ELECTRON HEATING. Lanzerotti, L. J.; Hasegawa, A.; Maclennan, C. G. (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res.; 74: 5565-78(1 Nov 1969).

The published $L = 5$ equatorial magnetosphere particle and field data from the April 18, 1965, geomagnetic storm are reanalyzed in the context of the drift-mirror instability theory developed by Hasegawa. These data, together with previously unpublished electron pitch-angle data, are shown to satisfy the requirements and consequences of the instability. Additional particle data observed during a 1967 substorm by an experiment on ATS 1 are also presented to show that the observation of the April 18 instability was not an isolated occurrence in the magnetosphere. The data also contain evidence for electron heating during the time of the instability. (auth)

5095 RELATIONSHIP BETWEEN A MONOCHROMATIC AURORAL ARC OF 6300 A AND A VISIBLE AURORA. Ichikawa, T.; Old, T.; Kim, J. S. (State Univ. of New York, Albany). J. Geophys. Res.; 74: 5819-21(1 Nov 1969).

This paper describes a relationship between a monochromatic midlatitude auroral arc of 6300 Å and a visible aurora observed on the night of Sept. 28/29, 1967, at Moscow, Idaho. (W.D.M.)

5096 INFLUENCE OF ELECTROMAGNETIC DRIFTS AND NEUTRAL AIR WINDS ON SOME FEATURES OF THE F_2 REGION. Sterling, D. L. (Southwest Center for Advanced Studies, Dallas); Hanson, W. B.; Moffett, R. J.; Baxter, R. G. Radio Sci.; 4: 1005-23(Nov 1969).

Solutions of the continuity equation for electrons in the F2 region of the earth's ionosphere are obtained by including parameters for the various physical processes experienced by the plasma moving in the electromagnetic-drift frame of reference. The electric field responsible for such a drift is derived from an electric potential, so the $E \times B/B^2$ drift velocity has an east–west component in addition to the usual vertical one. The Jacchia model atmosphere is used, and the description of the photoionization process uses the Chapman function for absorption of radiation by the neutral atmosphere. The ratio of electron temperature to ion temperature can be varied with time. Account is taken of recombination with both molecular oxygen and molecular nitrogen. Other processes included are diffusion and neutral air winds. The velocity of the neutral air winds is assumed to be zero at the equator for equinox conditions and at 15° latitude reaches a maximum of 35 m sec^{-1} directed away from the equator at 1300 LT and a maximum of 55 m sec^{-1} directed toward the equator at 0100 LT. It is shown that the east–west component of the electromagnetic drift has little effect on the solutions. For sunspot-minimum atmospheric conditions, better agreement with observations in the equatorial region is obtained when the vertical component of the electromagnetic drift velocity peaks at noon rather than at 1500 LT. The sunspot-maximum results show that there is a phase difference in the electromagnetic drift between sunspot-maximum and sunspot-minimum conditions. The overall magnitudes of equatorial N_mF2 agree fairly well with observations for both sunspot-minimum and sunspot-maximum conditions. The equatorward wind at night is a necessary feature to maintain N_mF2 at its observed levels at latitudes higher than about 10°. Within 10° of the equator winds do not play an essential role in the maintenance of the nighttime ionosphere. Preliminary results for a moderate latitude field line with a model variation of T_e/T_i show several features that are in accordance with Evans' data for the period when the evening increase in N_mF2 occurs. (auth)

Low-Temperature Physics

Refer also to abstracts 4399, 4773, and 5386.

5097 (IPP-4/67) CALCULATION OF THE MAGNETIZATION OF SUPERCONDUCTIVITY CYLINDERS OF TYPE III SUPERCONDUCTIVITY. Oswald, B. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1969. 31p. (In German). Dep. CFSTI (U. S. Sales Only).

The field distribution and the magnetization of long cylindrical superconductors of type III are computed. The entire magnetization loop, beginning at zero field, is divided in five sections and analyzed by five corresponding equations. The theory allows an accurate evaluation of the I–H characteristic of superconducting materials. (auth)

5098 (UCRL-50514(Rev.1)) SOUND SUPPORTED SPHERE IN He II. Ensley, D. L. (California Univ., Livermore. Lawrence Radiation Lab.). June 10, 1969. 29p. Dep. CFSTI.

Experiments have been performed in which a megahertz sound field was used to generate a time-average force field in liquid He II that successfully supported a metal ball. Extremely small disturbing torques act upon the suspended mass, because the field forces are spherically symmetrical and naturally stable. The isothermal environment provided by the He II eliminates convection currents as well as dimensional fluctuations of the materials. This is a good example of the "Principle of Dynamic Stability." (auth)

5099 OBSERVATION OF SUPERFLUID-HELIUM PERSISTENT CURRENT BY DOPPLER-SHIFTED SPLITTING OF FOURTH-SOUND RESONANCE. Rudnick, I.; Kojima, H.; Veith, W.; Kagiwada, R. S. (Univ. of California, Los Angeles). Phys. Rev. Lett., 23: 1220-3(Nov. 24, 1969).

Persistent currents in superfluid helium contained in the pores of a packed powder were observed by means of the Doppler-shifted splitting of an azimuthal resonant fourth-sound mode of the cylindrical resonator containing the helium. (auth)

5100 HALL EFFECT IN DIRTY TYPE-II SUPERCONDUCTORS. Maki, Kazumi (Tohoku Univ., Sendai). Phys. Rev. Lett., 23: 1223-5(Nov. 24, 1969).

The Hall effect in the vortex state of a dirty type-II superconductor is re-examined microscopically. The inclusion of the kinetic-energy term of the moving pair (which was completely neglected by Caroli and Maki) in the chemical potential results in a large Hall effect in the vortex state consistent with experiments on Nb–Ta alloys by Niessen et al. Furthermore, it is shown that for a dirty superconductor, the Hall angle of the vortex state in the zero induction limit reduces to a constant value independent of temperature. (auth)

5101 FREQUENCY-PULLING EFFECTS IN JOSEPHSON RADIATION. McCumber, D. E. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett., 23: 1228-31(Nov. 24, 1969).

Contrary to recent suggestions, cavity detuning per se does not modify the Josephson relation $\omega_J(V) = 2eV/\hbar$, although it can produce measurable differences between the electrostatic and electrochemical potentials in a Josephson junction. (auth)

5102 TUNNELING CURRENTS FROM SUPERCONDUCTING LEAD FILMS IN A PARALLEL MAGNETIC FIELD. Rothman, H. (Technion–Israel Inst. of Tech., Haifa). Physica, 44: 353-80(Sept. 29, 1969).

Films of pure lead, having different thicknesses between 3200 and 700 Å were studied by tunneling in aluminum/barrier/lead sandwiches at 4.2, 2.54 and 2.14 °K, in a parallel magnetic field. The tunneling characteristics yielded, by graphical analysis, the relative conductance at zero bias voltage. These permitted determination of the critical thicknesses for both surface and bulk superconductivity at the three mentioned temperatures. The measured tunneling currents were compared in the different ranges of magnetic field intensity with values computed with the aid of different theoretical models. In weak fields, the agreement with the BCS theory seems good up to 0.4 of the upper transition field, but a gap-filling tendency is observed immediately on the application of the magnetic field. In the range around the upper transition field, agreement with the De Gennes–Maki theory seems good. The gapless range coincides, for the thicker films, with that of surface superconductivity. In the intermediate range, the lead films differ from superconductors with a short mean free path in that the gap is more densely populated in the former, and the conductivity of the sample in the superconducting state equals that in the normal state at a higher potential difference, in qualitative agreement with the Orsay group theory for pure second-type superconductors. In order to compare the critical thickness for the superconducting transition in the bulk of the sample (at which change from first to second order takes place) with that expected according to the Ginzburg–Landau theory, the effective parameter k and the penetration depth were determined from the present measurements; the former showed a steep increase with decreasing thickness. In the diagrams constructed with the aid of the Ginzburg–Landau equations the critical thicknesses found at the three temperatures impinged on the boundary between the region where mixed state is possible in the bulk and that in which the bulk transition is a first-order one. (auth)

5103 ENERGY AND STABILITY OF VORTEX RINGS IN LIQUID HELIUM II: CRITICAL VELOCITIES. Van Vijfeijken, A. G.; Walraven, A.; Staas, F. A. (Philips Research Labs., Eindhoven, Netherlands). Physica, 44: 415-36(Sept. 29, 1969).

Quantized vortex rings in tubes of circular cross section are studied. The energy and momentum associated with confined vortex rings are calculated. It is shown that a confined ring carries no momentum. This fact makes the application of Landau's criterion for the critical velocity at which vortex rings are created, doubtful. A new criterion for v_c, based on mechanical equilibrium for a ring, is proposed and applied. It leads to an expression for v_c which contains both the diameter of the tube and the distance from the wall at which a ring is created. From a comparison with experiments this distance is estimated. In addition, the time needed for the creation of a ring is calculated. (auth)

5104 CHARGED-VORTEX-RING CREATION BY IONS IN SUPERFLUID HELIUM. Cunsolo, S.; Maraviglia, B. (Univ., Rome). Phys. Rev.; 187: 292-6(5 Nov 1969).

The critical-threshold electric fields and the critical velocities for the formation of charged vortex rings have been measured at temperatures $0.35 < T < 1$°K. Below $T = 0.85$°K, two different thresholds are shown to exist, connected with two different processes of formation. These two processes are found to be detectable only when a stability condition is satisfied. (auth)

5105 CONDUCTOR LOSSES IN SUPERCONDUCTING TRANSFORMERS. Borcherds, P. H. (Univ. of Birmingham, Eng.). Cryogenics; 9: 331-3(Oct 1969).

A formula is derived for the winding volume of a transformer, which can be used to calculate the "copper loss" in both conventional and superconducting transformers. The losses in superconducting transformers are calculated, it is shown that only for very large transformers does superconductivity become competitive. The results are discussed. (TSS) (UK)

5106 FEASIBILITY OF SUPERCONDUCTING POWER TRANSFORMERS. Lorch, H. O. (English Electric Co., Ltd., Stafford, Eng.). Cryogenics; 9: 354-61(Oct 1969).

The feasibility of making a 600-MVA 400-kV power transformer with superconductive windings to save I^2R losses is discussed, and the economic incentive assessed. Despite the radical change in concept, the transformer would be roughly the same size, shape, and weight as a conventional transformer. The tank would be vacuum tight, and the whole evacuated. This vacuum would insulate the windings electrically and thermally. Each winding would comprise two separate single layers of rectangular copper tube coated with superconductor and cooled internally with fluid helium at about 5°K. The extra cost of such a transformer is uncertain, but will probably exceed the saving in copper losses. (auth) (UK)

5107 BETTER PERFORMANCE AND SMALLER AC LOSSES OF SUPERCONDUCTING SOLENOIDS BY METALLURGICAL MEANS. Lange, F.; Verges, P. (Deutschen Akademie der Wissenschaften, Dresden). Cryogenics; 9: 373-5(Oct 1969).

Production of j_c(H) curve as flat as possible will lead to considerably better stability against flux jumping in wires for superconducting solenoids without decreasing the current density in the interesting regions. Due to the corresponding reduction of maximum magnetization, lower ac losses will also result, and the contribution of wire magnetization to the coil field will decrease, which is important for high-homogeneity solenoids. Increasing the stability and decreasing the magnetization by this method is cheaper than producing the same results by reduction of the wire diameter. (auth)(UK)

5108 SOME REMARKS ON THE V-I CHARACTERISTICS OF COMPOUND SUPERCONDUCTORS. Cesnak, L.; Kokavec, J. (Electrotechnical Inst., Bratislava). Cryogenics; 9: 376-9(Oct 1969).

The voltage–current characteristics of stranded superconductors are discussed. Voltage jumps and the hysteresis in the rising and decreasing parts of the characteristic are explained in terms of a thin film thermal resistance between the superconductor and the stabilizer. By appropriate heat treatment of the superconductor, which is covered electrolytically with copper, this harmful effect can be eliminated. (auth) (UK)

5109 THE BEHAVIOR OF TYPICAL LIQUID HYDROGEN TARGET SYSTEMS UNDER SIMULATED FAILURE MODES. Soini, H. E.; Hoenig, M. O. (Cambridge Electron Accelerator, Mass.). Advan. Cryog. Eng., 14: 473-5(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

A test program was conducted on typical CEA target systems. The tests, in which the target window were destroyed either alone or along with the vacuum vessel window, were carried out without and with ignition. No spontaneous ignition was observed. Suppression by Freon 1301 was found to be ineffective, but a dressed dummy within the flame front was not damaged. (D.L.C.)

5110 PROCEEDINGS OF THE Xth INTERNATIONAL CONFERENCE ON LOW TEMPERATURE PHYSICS, MOSCOW, USSR, AUGUST 31–SEPTEMBER 6, 1966. VOLUME II B. SUPERCONDUCTIVITY. Malkov, M. P. (ed.). Moscow; All-Union Scientific-Research Institute of Technology (1967). 382p. (In Russian and English). (CONF-660816–(Vol.2B)).

Eighty papers are included in this volume, 62 in English and 18 in Russian. Four of the English and one of the Russian papers are of summary or abstract length (one page or less). Practically all of the papers are devoted to basic theoretical or experimental investigations of superconductors or superconducting materials, with only a very few on engineering applications. (L.M.T.)

5111 ADVANCES IN CRYOGENIC ENGINEERING. VOLUME 14. Proceedings of the 1968 Cryogenic Engineering Conference, Case Western Reserve University, Cleveland, Ohio, August 12–21, 1968. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1969. 491p. $25.00. (CONF-680813).

A total of 59 papers are included, along with author and subject indexes. The following topics are covered: national goals in the cryogenic industry, propulsion, thermodynamic properties, materials properties, superconductivity, heat transfer, insulation, fluid dynamics, instrumentation, refrigeration systems, and cryogenic systems. Separate abstracts were prepared for 11 of the papers. (D.L.C.)

For abstracts of individual papers see: 5109 and 5112–5121.

5112 HIGH-FIELD MAGNET COMBINING SUPERCONDUCTORS WITH WATER-COOLED CONDUCTORS. Montgomery, D. B.; Williams, J. E. C.; Pierce, N. T.; Weggel, R.; Leupold, M. J. (Massachusetts Inst. of Tech., Cambridge). Advan. Cryog. Eng., 14: 88-97(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

General considerations are given for the design and costs of a hybrid magnet. A prototype hybrid system is described which consists of a water-cooled insert coil in a 14-in. room-temperature bore, 60-kg superconducting NbTi coil. Total fields of up to 300 kG can be produced. (D.L.C.)

5113 LARGE SUPERCONDUCTING BASEBALL MAGNET. Henning, C. D.; Nelson, R. L.; Calderon, M. O.; Chargin, A. K.; Harvey, A. R. (Univ. of California, Livermore). Advan. Cryog. Eng., 14: 98-105(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

A description is given of the design and structure of the 1.2-m dia superconducting baseball coil (whose conductor is shaped like the seam of a baseball) constructed for the Alice thermonuclear experiment. (D.L.C.)

5114 TESTING COMPOSITE SUPERCONDUCTOR FOR THE LRL BASEBALL MAGNET. Nelson, R. L.; Henning, C. D. (Univ. of California, Livermore). Advan. Cryog. Eng., 14: 106-13(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

The construction and performance testing of Nb_3Sn split-bar solenoids and composite Nb–Ti/Cu baseball sample conductors are described. The results indicate that a necessary condition for magnet operation above the nucleate-cooling stability limit is the current-sharing ability of the superconductor. (D.L.C.)

5115 TRANSIENT RESPONSE AND STABILITY LIMITS OF SUPERCONDUCTING COMPOSITE WIRE FOLLOWING A FLUX JUMP. Iwasa, Y.; Montgomery, D. B. (Massachusetts Inst. of Tech., Cambridge). Advan. Cryog. Eng., 14: 114-22(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

The transient behavior of current-carrying Nb–Ti copper composite wires after a flux jump initiated by a field pulse, was investigated. The voltage across the sample is monitored during and after the flux collapse. A thermal proximity effect was observed between the layers. Interleaving materials were tested for eliminating this effect, and sheets of nonwoven polyester fabric were found to be best. (D.L.C.)

5116 FLUX-FLOW STUDIES AND STABILITY CRITERIA OF Nb-Ti STRIPS. Lubell, M. S.; Kroeger, D. M. (Oak Ridge National Lab., Tenn.). Advan. Cryog. Eng., 14: 123-32(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

Complete test cycles (superconducting to flux flow to normal and back to flux flow) were carried out on bare strips of three Nb–Ti alloy compositions (5, 10, and 25% Ti) in unrestricted He flow. From the flux-flow and critical-current measurements, the take-off power, recovery power, and flux-flow resistivity were determined. It is shown that the take-off power can be explained by temperature fluctuations due to local changes in heat transfer and a field-dependent minimum propagating current, and that the recovery power can give the heat flux as a function of temperature for the fiber boiling regime. (D.L.C.)

5117 THE TRANSITION TO CURRENT-SHARING IN COMPOSITE CONDUCTORS. Fairbanks, D. F. (Norton Co., Natick, Mass.). Advan. Cryog. Eng., 14: 133-7(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

The experimental stability behavior of copper composites of Nb–48% Ti strands and the Stekly–Zar analysis of the stability criterion are reviewed. The data are plotted as current capacity vs power dissipation and yields the value 0.11 W/cm^{2}°K, which is about one-fourth of the experimental value. It is concluded that the current-sharing stability of composites can be dominated by thermal resistances within the composite. (D.L.C.)

5118 STABILITY OF INTERNALLY COOLED SUPERCONDUCTORS. Greene, W. J. (Air Reduction Co., Murray Hill, N. J.); Saibel, E. Advan. Cryog. Eng., 14: 138-45(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

The internal cooling of hollow composite superconductors by He offers advantages over coil immersion in He. A theoretical study was made of the stabilization problem under these conditions. Differential equations for the upstream superconducting, normal, and downstream superconducting regions are solved to find the critical length of the normal zone. The equations were used to study the stability characteristics of Nb–Ti/Cu composites; the critical length was found to reach a maximum at a current of 1850 A. Maximum power dissipation occurs at 2000 A. Above 2500 A, the upstream edge of the normal region propagates counter to the gas flow (unstable region). (D.L.C.)

5119 EFFECTS OF NUCLEATE COOLING LIMITS ON THE PERFORMANCE OF SMALL Ti–Nb SOLENOIDS. Purdy, V. (Univ. of California, Los Angeles); Frederking, T. H. K.; Boom, R. W.; Guderjahn, C. A.; Domoto, G. A.; Tien, C. L. Advan. Cryog. Eng., 14: 146-58(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

Experiments were performed on three laboratory-size Ti–Nb composite solenoids designed using the nucleate cooling concept. Heat-flux densities were calculated for these solenoids. Investigations were conducted to clarify the nature of nucleate cooling limits applicable to solenoids with small cooling channels. The results suggest that the nucleate cooling limit in a superconducting solenoid must be a function of the size of the dissipative area. (D.L.C.)

5120 NON-BOILING AND FILM BOILING HEAT TRANSFER TO A SATURATED BATH OF LIQUID HELIUM. Goodling, J. S.; Irey, R. K. (Univ. of Florida, Gainesville). Advan. Cryog. Eng., 14: 159-69(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

Heat flux measurements were made on helium-II and -I to investigate deviations from the Khalatnikov theory and the dependence of peak flux on both temperature, depth, and test section diameter. (D.L.C.)

5121 CLOSED-CYLE REGRIGERATORS FOR HYDROGEN TARGETS. O'Neil, J. A. (500 Inc., Cambridge, Mass.). Advan. Cryog. Eng., 14: 423-9(1969).

From Cryogenic Engineering Conference, Cleveland, Ohio. See CONF-680813.

An investigation was conducted of the interface and operating problems and the characteristics of hydrogen targets cooled by remotely operated closed-cycle He refrigerator. The refrigerator was a standard He refrigerator rated at 2 to 3 W but uprated to the 5 to 7 W required for the H_2 condenser. The tests were made on a dummy target, a DESY target, and a CEA target, and as a result of the tests, design changes were made, resulting in the Cryodyne Refrigerator Model 342 Hydrogen Condenser/Recondenser. (D.L.C.)

5122 RADIANT ENERGY DETECTION USING TIN SUPERCONDUCTING FILMS. Bertin, Claude L. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 220p.

Thesis.

Higher-resistance films than were studied by other investigators were used to provide a better match to the incident radiation. Thin tin-film devices were produced that are superior in performance, based on speed and sensitivity, to previous superconducting bolometers, and are comparable in performance to existing cryogenic germanium bolometers. High-speed operation was realized by placing the film in direct contact with the liquid helium bath, thereby achieving time constants of about 10 ns. From the characteristics of a number of films, equations relating bolometer performance to material properties were derived and extrapolated to predict the ultimate response for tin bolometers under conditions of both device- and amplifier-noise-limited operation. For tin limited by device, Johnson, and temperature noise, a time constant $\tau = 10$ ns and an area of 1 cm^{2} were obtained. Measurements on films from 3.5 K $\Omega/\square$ to 0.01 $\Omega/\square$ showed a decrease in responsivity from 200 to 1 as the resistance was decreased. The detection mechanisms for thin superconducting tin films are more complicated than was at first imagined. For high-resistance films, an enhanced microwave response was measured at temperatures well below T_c for 9.4 and 35 GHz radiation but not for light of 1-μm wavelength. This effect is compatible with rectification due to the nonlinear V–I characteristic, and was measured as more than three orders of magnitude more sensitive to microwaves than the bolometer mode. Responsivities of 12,700 V/W have been achieved yielding NEP = 4.85×10^{-13} W–Hz$^{-1/2}$ for a film of 11.4K $\Omega/\square$ sheet resistance. No observable effect was present below 40 $\Omega/\square$. Films have low impedances at their operating temperatures (<100 $\Omega/\square$ for both bolometer and enhanced mode) and ideal geometry for high-speed operation. Detailed comparison of bolometer and enhanced-mode performance with other superconductor and semiconductor devices is included to place this work in perspective. (Diss. Abstr.)

5123 STUDY OF WEAK SUPERCONDUCTIVITY. Lebwohl, Paul Allen. New Haven; Yale Univ. (1968). 94p.

Thesis.

The behavior of a thin dielectric barrier between two superconductors is investigated by solving the equation derived by Josephson for the phase jump across the barrier. In very small electric and magnetic fields the barrier exhibits a Meissner effect, excluding all fields; at higher magnetic fields the barrier goes into a mixed state having a vortex structure. The small oscillation solutions about these vortex structures are determined. The coherence of the barrier is investigated by quantizing the phase jump. The coherence is found to depend logarithmically on the temperature, T, the length of the barrier, and the time between the measurements. All experimental barriers can be considered to be fully coherent. The tunneling current consists of two components, quasiparticles and Cooper pairs; only the Cooper pairs tunnel at T = 0°K. Because of the existence of the energy gap the quasiparticle tunneling power spectrum at T = 0°K has no components for $\omega < 2\Delta$; this results in a correlation time for the quasi-particle current of $T_c < \hbar/_{2\Delta}$, a very small number. (Diss. Abstr.)

5124 RATIO OF SURFACE TO BULK NUCLEATION CRITICAL FIELDS, H_{c3}/H_{c2}, FOR PURE SUPERCONDUCTORS IN THE NON-LANDAU-GINZBURG REGION. Hu, Chia-Ren. College Park; Univ. of Maryland (1968). 158p.

Thesis.

The ratio of surface-to-bulk-nucleation critical fields, H_{c3}/H_{c2}, for semi-infinite pure superconductors separated from a vacuum or an insulator by a specularly reflective plane boundary, is studied for both $T \cong 0$°K and near the Landau–Ginzburg region (as defined by $T_c - T \ll T_c$). Gor'kov's microscopic formulation of superconductivity theory is employed. A generalized image method is first developed to obtain the normal electron temperature Green's function pertaining to the given sample geometry. The appropriate linearized gap equation for such a sample is then derived for T = 0°K, this linear homogeneous integral equation is then solved by a variational method using a gaussian as the trial wave function. The result $H_{c3}/H_{c2} \geq 1.925$ is obtained, compared with Saint-James and de Gennes' result, ~1.7, for this ratio in the Landau–Ginzburg region. The result is then extended to small but nonvanishing T by a perturbational method, and the leading term in the temperature dependence of the ratio is found to be $0.05\ T^{2} \ln T$ for small T. For $T \simeq T_c$, two approaches are employed to calculate H_{c3}/H_{c2}. In the first approach, the conventional assumption that the pair wave function is everywhere slowly varying inside the sample is made. It leads to a simultaneous, microscopic derivation of the linearized Landau–Ginzburg equation and its supplementary boundary condition, for samples with a boundary, when $T_c - T \ll T_c$. This approach is shown to be not self-consistent for temperatures below the Landau–Ginzburg region. The second approach, allowing for the rapidly varying nature of the pair wave function near the sample surface, is then used. The lowest two nontrivial orders in $(1-t)^{1/2}$ are found as corrections to the result $H_{c3}/H_{c2} = 1.7$, when T gets slightly below the Landau–Ginzburg region, and find that H_{c3}/H_{c2} decreases as the temperature is lowered in this region. The qualitative behavior of this ratio in the whole temperature region below T_c is speculated about and it is thought to possess a minimum at some temperature not very far below T_c. Comparison between this calculation and some other presently existing theories are also made. Finally, two criteria concerning the optimum nucleation modes are studied. (Diss. Abstr.)

5125 A STUDY OF SUPERCURRENTS AND ELECTRON DEPAIRING IN SUPERCONDUCTING TIN FILMS. **Bhatnagar, Anil Kumar.** College Park, Md.; Univ. of Maryland (1968). 200p.

Thesis.

The supercurrent induced in thin films of tin as a function of the applied magnetic field was measured. The tin film forms a part of the multiply connected sandwich-type superconducting sample made by deposition of lead, magnesium fluoride, tin and lead films, respectively, on a substrate of gold foil. The latter films of lead are not deposited on the whole length of the sample, but only at the ends so as to keep the central portion of the tin film exposed. These lead films act as guard rings to maintain a uniform current density throughout the whole length of the exposed tin film. The strength of the induced supercurrent in the tin film is measured by a sensitive apparatus especially designed for the measurement of the magnetic moment of very small samples. In the experiment reported here, it is shown that the behavior of the supercurrent, as a function of the applied magnetic field, does indeed depend upon the geometrical factors of the sample used, and by varying these factors it was possible to observe the transformation of the tin film from the supercurrent-carrying state to the nonsupercurrent-carrying state occurring abruptly as well as gradually, corresponding to a first-order phase transition and a second-order phase transition, respectively. This is the first successful experimental effort, to the knowledge of the author, to observe the depairing regime (i.e., the gradual disappearance of the supercurrent after it reaches a maximum value). The depairing curves, the critical vector potential for complete depairing of Cooper pairs, and London penetration depth for tin films were deduced from the experimental data. A comparison of these with the BCS, Maki, and Ginzburg–Landau theories was made. It was found that the experimental results are in better agreement with the Ginzburg–Landau theory than with the BCS or Maki's calculations for a dirty superconductor. However, Maki's calculations, when modified for temperature dependence by using the equivalence between the current case and the case of paramagnetic impurities in a superconductor, predict values of the critical vector potential which are in somewhat better agreement with the data than are those obtained from the Ginzburg–Landau theory. A study of the hysteresis in the depairing curves was also attempted, but not in detail. The results are too scanty to be conclusive. (TCC) (Diss. Abstr.)

5126 METALLOVEDENIE SVERKHPROVODYASHCHIKH MATERIALOV. (Metallography of Superconductors). **Savitskii, E. M.; Baron, V. V.; Efimov, Yu. V.; Bychkova, M. I.; Myzenkova, L. F.** Moscow, Izdatel'stvo Nauka, 1969. 268p.

The principal concepts of the theory of superconductivity and properties and applications of superconducting metals are reviewed. The transition temperature, critical magnetic fields, microstructure, and effects of deformation and impurities on the superconducting properties of elements are discussed. Physicochemical analysis of superconducting systems, thermal treatment, technology, preparation, and applications of superconductors (magnets, memory devices, masers, magnets for thermonuclear devices, accelerators, bubble chambers, gyroscopes, MHD generators, etc.) are described. 112 references are included. (R.V.J.)

5127 EFFECT OF PRESSURE ON THE TRANSITION TEMPERATURE OF Pb. **Wu, T. M.** (State Univ. of New York, Binghamton). **Phys. Lett.; 30A: 347-8(17 Nov 1969).**

The pressure-dependent transition temperatures of Pb were calculated, using the empirical values of the phonon spectrum and the Coulomb pseudopotential. (auth)

5128 PRESSURE DEPENDENCE OF VISCOSITY IN LIQUID HELIUM. **Goodwin, James Meyers.** Seattle; Univ. of Washington (1968). 173p.

Thesis.

The viscosity of liquid helium has been an interesting and puzzling phenomenon since its earliest measurements. The vibrating wire viscometer, an instrument developed at this laboratory, was previously used here to measure the viscosity of liquid helium in equilibrium with its saturated vapor, below the lambda transition which occurs at 2.172 °K. These measurements are extended by the present work, to temperatures of up to 4.20 °K and to the region of elevated pressures, up to approximately 25 atm of pressure. An improved data-reduction technique has been used which allows an improvement on the accuracy and convenience of the older measurements. A comparison is made with other measurements of viscosity, both above and below the lambda transition, at the vapor pressure. Good agreement is seen with other measurements, but disagreement with measurements using oscillating disk techniques is observed. A comparison is made with such other experimental measurements which have been made at elevated pressures by other methods. A comparison with the theoretical predictions due to Landau and Khalatnikov is made. It is seen from this comparison that the theory cannot accurately predict the pressure dependence of the viscosity, and that the predicted temperature dependence is also incorrect. It is concluded that the viscosity due the roton–roton interaction is incorrectly treated by the theory. (Diss. Abstr. Int., B)

5129 PEAK EFFECT IN TYPE-II SUPERCONDUCTORS: YIELD POINT OF THE FLUXON LATTICE. **Chang, C. C.; McKinnon, J. B.; Rose-Innes, A. C.** (Univ. of Manchester, Eng.). Phys. Status Solidi; 36: 205-9(1 Nov 1969).

The complicated current–voltage (flux flow) curves obtained from type-II superconductors that show the peak effect are compared to the stress–strain curves of crystalline materials in which plastic flow at low stresses is prevented by pinning of dislocations. It is suggested that the unstable step in the current–voltage characteristic is the result of "yield" and subsequent shearing of the fluxon lattice by dislocation motion. (auth)

5130 VACANCY LINES AND STACKING FAULTS IN VORTEX LATTICE OF TYPE-II SUPERCONDUCTORS IN THE LONDON APPROXIMATION. **Brandt, E. H.** (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi; 36: 371-9(1 Nov 1969). (In German).

The energy and lattice distortion of a vacancy with highest symmetry and of an infinite stacking fault in the vortex lattice of superconductors with $\varkappa \gg 1$ near H_{c1} are calculated using methods given in a previous paper. The results obtained by various methods are compared. The range of validity and the numerical computation of these methods are discussed. (auth)

5131 CALCULATIONS ON DEFECTS IN VORTEX LATTICE OF TYPE-II SUPERCONDUCTORS NEAR H_{c2}. **Brandt, E. H.** (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi; 36: 381-91(Nov. 1, 1969). (In German).

Abrikosov's method for calculating energy and structure of a periodic vortex lattice in type-II superconductors near H_{c2} by means of the linearized Ginsburg–Landau equations is extended to defects of the vortex lattice. The energy of the defect may be expressed as an integral over the whole superconductor. By varying this expression one obtains the displacement field associated with the defect. The shear modulus of the vortex lattice is calculated. As $H_a \rightarrow H_{c2}$ both the defect energy and the shear modulus tend to zero as $(H_{c2}-H_a)^2$. (auth)

5132 VACANCY LINES IN VORTEX LATTICE OF TYPE-II SUPERCONDUCTORS NEAR H_{c2}. **Brandt, E. H.** (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi; 36: 393-406(Nov. 1, 1969). (In German).

Energy, lattice distortion, Ginsburg–Landau function (or order parameter), and the microscopic magnetic field of a vacancy with highest symmetry in the vortex lattice of type-II superconductors near H_{c2} are calculated using a method given in a previous paper. The lattice distortion at large distances from an arbitrary localized lattice defect is given. (auth)

5133 SUPERCONDUCTORS CONTAINING IMPURITIES WITH CRYSTAL-FIELD SPLIT ENERGY LEVELS. **Fulde, Peter** (Univ., Frankfurt am Main); **Hirst, L. L.; Luther, Alan.** Z. Phys.; 230: 155-77(1970).

The problem of a superconducting matrix containing paramagnetic rare earth impurities with crystal-field split energy levels is investigated theoretically. There are two competing mechanisms which change the superconducting transition temperature T_c. One is inelastic charge scattering of conduction electrons from the aspherical part of the 4f charge distribution, which leads to an increase in T_c similar to that of optical phonons. The other and often predominant mechanism comes from the exchange interaction, which depresses T_c and can be very effective even among nonmagnetic levels via off-diagonal matrix elements. Crystalline fields serve to alter the effectiveness of the two kinds of scattering depending upon the symmetry character of the low-lying levels, and in favorable cases one may study separately the effects of the two types of scattering by adding different impurities to a given host. It is found that crystal-field levels at energies quite high compared to $k_B \cdot T_c$ can still have an important effect on T_c. It is shown that the crystalline-field splitting should be directly observable as structure in the tunneling characteristics. (auth)

5134 BOUND AND CONTINUUM STATES OF A VORTEX LINE IN A PURE TYPE-II SUPERCONDUCTOR. **Bergk, W.; Tewordt, L.** (Univ., Hamburg). **Z. Phys.; 230: 178-92(1970).**

The Bogolyubov equations for the quasi-particle excitations of an isolated vortex line in a pure type-II superconductor are solved by means of a method due to Bardeen et al. The low lying energy levels of the bound states are found to have the form of Landau levels where the effective field is determined by the pair potential and the magnetic field in the core region of the vortex. From the solutions of the continuum states of high energy simple expressions for the phase shifts are derived. The contributions of the continuum states to the pair potential and the current density are calculated. The pair potential is shown to tend to the BCS gap parameter, and thus to be self-consistent, at large distances from the vortex axis. (auth)

5135 DETERMINATION OF THE ELECTRICAL RESISTANCE OF A SUPERCONDUCTOR IN THE INTERMEDIATE STATE ON THE BASIS OF ITS MAGNETIC INDUCTION DISTRIBUTION. Freud, R. (Inst. of Low Temperatures and Structural Research, Wroclaw). Acta Phys. Pol.; 36: 787-9 (Nov 1969).

The geometry of the distribution of superconducting and normal domains found by the bismuth probe technique, with a known specific resistance of the bulk sample in the normal state, can be utilized for determining the value of the sample's electrical resistance unperturbed by the shortening of the free path of conduction electrons due to their reflection at the surfaces of the superconducting domains. (auth)

5136 TIME-DEPENDENT GINZBURG–LANDAU EQUATION FOR SUPERCONDUCTING ALLOYS IN HIGH MAGNETIC FIELDS. Weller, W. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Status Solidi; 35: 573-9(1 Oct 1969).

A superconductor containing nonmagnetic impurities is considered in the limit of small mean free path ($l \ll \xi_0$) and high magnetic field ($H \approx H_{c2}$). With the help of the method developed by Gorkov and Eliashberg the time-dependent Ginzburg–Landau equation and the differential equation for the vertex part are derived from the microscopic theory. The resulting Ginzburg–Landau equation is appreciably simplified in the cases, in which the vertex part reduces to the scalar electromagnetic potential. It is shown that this simplification is possible for the case of slow motion of the lattice of the vortex lines (flux-flow) caused by a static electric field. (auth)

5137 CALCULATIONS ON DEFECTS IN VORTEX LATTICES OF TYPE-II SUPERCONDUCTORS IN THE LONDON APPROXIMATION. Brandt, E. H. (Max-Planck Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi; 35: 1027-41(1 Oct 1969). (In German).

Methods are given for calculating the energy and lattice distortion of defects of the vortex lattice of superconductors with $\varkappa \gg 1$ near H_{c1}. The elastic constants of the vortex lattice and the binding energy of a vortex line are calculated. It is shown that in all calculations one has to consider the interaction of a vortex line with many neighbors, since otherwise the lattice would be unstable. (auth)

5138 ON SOME ASPECTS OF SUPERCONDUCTIVITY. Berard, A. Inter Electron.; 23: 64-9(Nov 1968). (In French).

Current aspects of progress in superconductivity are reviewed. General aspects of superconductivity are noted, and theories compared. A comparison of superconducting behavior and that of living substances under certain conditions is made; studies of large conjugated organic molecules bridge these areas and provide a field for future study in polymer chemistry. The collection of information on slow polarization is contrasted with the action of weak magnetic fields and that of the earth's magnetic field on artificial substances; a rhythm more or less associated with the rotation of the earth has been discovered. More precise results await reports from a specially constructed station in Brittany. The nature of the isotope effect is confused; difficulties seem to arise if the isotope effect is tied directly to the atomic masses of different elements. It is suggested that the classification of "soft" and "hard" superconductors be dropped. Application of superconductors is certain even though a complete unassailable theory does not yet exist. (BBB)

5139 MAGNETIC SPHERES IN A SUPERCONDUCTOR. Hurault, J. P.; Pincus, P. (Univ. of California, Los Angeles). J. Low Temp. Phys.; 1: 129-35(Jun 1969).

A cubic lattice of small magnetic spheres embedded in a type-II superconductor is considered. The field distribution for one sphere and the interaction energy when the moments are aligned are computed. It is pointed out that the dipolar field due to the nearest neighbors, in opposition to the normal situation, is nonzero in the superconducting state and induces then an antiferromagnetic ordering of the moments. (auth)

5140 DETERMINATION OF PINNING FORCES FROM MAGNETIZATION CURVES OF WIRES. Dichtel, K.; Koppe, H. (Univ., Kiel. Neue Univ., Kiel). J. Low Temp. Phys.; 1: 137-52(Jun 1969).

Methods are developed for the numerical calculation of pinning forces resp. critical current densities J_c from experimental magnetization curves of cylinders. Application to Pb–Tl and Pb–In samples indicates a general law $J_c = I_0(1 - H/H_{c2})^{\mu}$ for well-annealed samples and large H near H_{c2}, where the constant μ depends on the composition and possibly the temperature. The application of the method to neutron-irradiated Nb samples shows that the peak effect is much more pronounced in the $J_c(H)$ curve than in the magnetization curve. (auth)

5141 CRITICAL HEAT FLOW IN A THICK He II FILM NEAR THE SUPERFLUID TRANSITION. Ahlers, Guenter (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Low Temp. Phys.; 1: 159-72(Jun 1969).

Measurements of critical heat flow in a thick He II film near the onset temperature T_0 are presented. Estimates of the film thickness were made by comparison with the critical velocity for bulk helium in pores, and from the onset temperature for superfluidity. These comparisons yield a thickness of 2.5×10^{-5} and 2×10^{-6} cm, respectively. The observed critical heat flow, in conjunction with reasonable estimates of the superfluid density, yields a critical velocity v_{sc}^* that has the same temperature dependence as the critical velocity v_{sc} obtained by Clow and Reppy from gyroscopic measurements. The present results are consistent with the idea that there is a region near T_0 where $v_{sc}^* = v_{sc} \propto \rho_s$ and it is independent of geometry, and a geometry-dependent region well below T_0 where $v_{sc}^* = v_{sc} \cong$ constant. Available data on the depression of the onset temperature are examined. Although they are consistent with recent phenomenological calculations, they are not sufficiently accurate to provide conclusive evidence in favor of these theories. (auth)

5142 IONIC CURRENTS MODULATED BY FILM FLOW IN SUPERFLUID HELIUM. Bianconi, A.; Maraviglia, B. (Univ., Rome). J. Low Temp. Phys.; 1: 201-13(Jun 1969).

The oscillations of two helium baths coupled by the saturated film were studied with a new method employing positive ions. The sensitivity of such a method for the variation of liquid-level height is found to be of the order of 10^{-6} cm. The film current was observed to be modulated with a frequency double that of the level oscillations. This interesting new feature is discussed in the framework of the present theory of liquid helium. (auth)

5143 FLUCTUATIONS AND THE SUPERCONDUCTING PHASE TRANSITION: CRITICAL SPECIFIC HEAT AND PARACONDUCTIVITY. Ferrell, Richard A. (Univ. of Maryland, College Park. Univ. de Paris, Orsay, France). J. Low Temp. Phys.; 1: 241-71(Jun 1969).

A general discussion is given of the role of fluctuations in introducing new effects in a superconductor at temperatures just above its transition temperature. In this region the BCS theory of superconductivity, a type of mean-field theory, does not predict any variation from normal-state behavior until the critical point is reached. But the close analogy between the superconducting phase transition and other phase transitions requires the appearance of deviations from normal state behavior. The existence of a strong rise in the electrical conductivity, or "paraconductivity," has been verified by Glover. A review of the phenomenological Landau–Ginzburg theory describing this effect is presented, as well as a calculation of the critical variation in the specific heat. A measurement of the latter effect would constitute an important check on the theory. (auth)

5144 THE λ TEMPERATURE OF ROTATING LIQUID HELIUM. Andelin, J. (Ford Scientific Lab., Newport Beach, Calif.); Pobell, F.; Wagner, F. J. Low Temp. Phys., 1: 417-21 (Oct. 1969).

The λ temperature of liquid ^{4}He in an annulus was found to be independent of rotation to $\pm 10^{-6}$°K for $\omega \leq 35$ sec^{-1}, even if the rotating liquid is allowed only 0.5 min in the He II state to come to rotational equilibrium. This result is in disagreement with a recent publication. (auth)

5145 FLUCTUATIONS AND THE SUPERCONDUCTING PHASE TRANSITION. II. ONSET OF JOSEPHSON TUNNELING AND PARACONDUCTIVITY OF A JUNCTION. Ferrell, Richard A. (Univ. of Maryland, College Park. Univ. de Paris, Orsay, France). J. Low Temp. Phys.; 1: 423-42(Oct 1969).

When one metallic film of a tunneling junction is in the superconducting state but the other is above its transition temperature, fluctuations in the pair field of the second film cause instantaneous Josephson currents to flow. Application of the Kubo formula to these current fluctuations yields a conductivity with a strong temperature dependence, tending to infinity at the transition. The numerical magnitude of this "paraconductivity" is sufficiently large to be observable for junctions of very low normal resistance (and may possibly be compared with some recent measurements of Lipson et al.). High-frequency studies would determine directly the pair relaxation rate. An experimental advantage of tunneling paraconductivity is that it is not sensitive to the electron mean free path and therefore does not require amorphous films. (auth)

5146 MAGNETOTHERMAL OSCILLATIONS AND THE FERMI SURFACE OF β-TUNGSTEN V_3Ge. Graebner, J. E.; Kunzler, J. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Low Temp. Phys., 1: 443-50(Oct. 1969).

Landau quantum oscillations have been observed for the first time in a high-critical-field superconductor with the β-tungsten crystal structure. The data are associated with extremal orbits on three sheets of the Fermi surface, all three resembling $\langle 100 \rangle$-directed cylinders. The results are compared qualitatively with a Fermi surface model suggested by APW energy band calculations. (auth)

5147 PARACONDUCTIVITY IN TYPE-II SUPERCONDUCTORS. Maki, Kazumi (Tohoku Univ., Sendai). J. Low Temp. Phys.; 1: 513-18(Oct 1969).

The additional conductivity due to the fluctuation of the order parameter in dirty type-II superconductors is reconsidered. It is shown that in a magnetic field H slightly above the upper critical field the electric conductivity is strongly anisotropic depending on the relative direction of the magnetic field and the electric current. In the parallel case (i.e., $H \parallel J$) the conductivity diverges like $(H-H_{c2})^{-3/2}$, while in the perpendicular case ($H \perp J$) it diverges like $(H-H_{c2})^{-1/2}$. (auth)

5148 ELECTRON-TUNNELING STUDY OF THE FLUXOID STRUCTURE IN THIN SUPERCONDUCTING FILMS. Nedellec, P.; Guyon, E.; Brochard, F. (Faculte des Sciences, Orsay, France). J. Low Temp. Phys.; 1: 519-37(Oct 1969).

The subcritical gapless behavior of superconducting In–Bi thin films in a perpendicular magnetic field was studied by electron tunneling. The variation of the initial slope of the tunneling characteristics with field gives quantitative information on the variation of the pair potential and allows a comparison with the various existing models. The important contribution of the macroscopic screening currents in the films due to the large demagnetizing effects for this geometry is confirmed. It is also found that the effect of the decrease of the microscopic screening currents of the vortex structure for very thin film was largely compensated by the increasing role of the inhomogeneous field distribution outside the sample. (auth)

5149 HIGH FREQUENCY ABSORPTION IN ULTRAHIGH-VACUUM EVAPORATED SUPERCONDUCTING LEAD LAYERS. Flecher, P. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Instrum. Methods; 75: 29-31(1969). (In German).

Results of high-frequency absorption measurements in the superconducting state at 2.6 GHz of pure lead and of lead–bismuth alloys, prepared in a new ultrahigh-vacuum apparatus, are presented. (auth)

Plasma and Thermonuclear Physics

Confinement and Heating

Refer also to abstracts 5113 and 5181.

5150 (AEC-tr-7072) CONFINEMENT OF PLASMA IN STELLARATORS. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of a Russian report. 54p. Dep. CFSTI.

A collection of 9 papers is presented: (1) quasi-constant electric fields in the L-1 stellarator, (2) fluctuations in plasma density in L-1 stellarator, (3) electron cyclotron heating in L-1 stellarator, (4) pulse vacuum measurements on L-1 stellarator, (5) the TOR-1 closed trap with helical magnetic field, (6) the TOR-2 installation, (7) magnet coils of the TOR-2 installation, (8) localization of discharge in a conical induction plasma source, and (9) a single-process photoelectric spectrum analyzer. (M.O.W.)

5151 (CONF-690619-15) POSSIBLE MECHANISM OF PLASMA DIFFUSION IN STELLARATOR L-1. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kovrizhnykh, L. M.; Kossyi, I. A.; Sbitnikova, I. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 8p. (In Russian). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

The abnormally high rate of plasma diffusion in closed systems in the L-1 stellarator was analyzed, and published data on the mechanism of plasma escape from traps are discussed. An attempt was made to correlate the experiments with diffusion theory, using calculations of equilibrium electric fields and plasma lifetime parameters close to experimental. Results showed that the theory, obviously predicted correctly the magnitude of equilibrium electric fields, however, there was a difference between the experimentally observed and calculated time of plasma confinement. Observations of L-1 plasma potential functions and the confinement time indicate that losses are primarily due to collisional diffusion. (R.V.J.)

5152 (IPP-2/78) ON THE POTASSIUM CONFINEMENT IN THE GARCHING OCTOPOLE W V. Rau, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 22p. Dep. CFSTI (U. S. Sales Only).

Primary losses corresponding to a confinement time τ_{s1} are by direct loss of the gyrating ions at the surfaces of the supports. The calculated confinement time due to those primary losses is independent of the density. Secondary losses corresponding to a time τ_{s2} can be caused by an azimuthal density gradient. Depending on its direction, secondary losses are either towards the outer walls or towards the rings, the direction of the magnetic field being given. In the simple model treated here, instead of the density gradient only the ratio n_1/n_0 enters where n_1 is the density measured at an azimuth where supports are located and n_0 is the corresponding density at other azimuthal positions. With the use of the experimental data as obtained until now, an experimental confinement $\tau = 0.2$ s as well as loss times $\tau_{s1} = 0.5$ to 0.8 s and $\tau_{s2} = 0.6$ to 0.04 s are found for a potassium plasma, in the purely meridional magnetic field of the Octopole W V. Considering the sheath effect on the primary loss flux to the supports the time τ_{s1} is to be reduced by a factor between 2 and 3. (auth)

Diagnostics

Refer also to abstract 5190.

5153 (IPP-1/94) LOCAL MEASUREMENT OF DENSITY AND ELECTRON TEMPERATURE IN COLLISIONLESS SHOCK WAVES BY LIGHT SCATTERING. Steuer, K.-H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan 1969. 45p. (In German). Dep. CFSTI (U. S. Sales Only).

Stationary, collisionless compression waves ($\beta_0 = 0.7$ to 2.2) were produced perpendicular to an initial magnetic field in a theta pinch (diameter 16 cm, length 60 cm) by a fast rising magnetic field (12 kG in 0.5 μsec). Investigation of the energy and density distributions of the electrons in these shock waves by 90° laser scattering ($\alpha \ll 1$) yields information on the nature of the energy dissipation and the resultant heating of the plasma. (auth)

5154 (IPP-2/77) SIGNAL PROCESSING MICROWAVE OPTICS BY MEANS OF MULTIPLE MODULATED SCATTERERS: APPLICATION TO A MICROWAVE IMAGE SCANNING SYSTEM. Wegrowe, J.-G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1969. 40p. Dep. CFSTI (U. S. Sales Only).

It is shown that using an array of modulated scatterers allows a variety of operations on an optical signal to be performed in a way similar to holography. As an application, a microwave image scanning system is described in detail. It permits the exploration of a microwave field with a single fixed receiver without loss of spatial resolution with regard to the corresponding purely optical device, and with a good time resolution. Preliminary experimental results obtained with such a device are given. (auth)

5155 (IPP-3/98) POSSIBILITIES FOR PLASMA DIAGNOSTICS WITH INFRARED LASERS. Keilmann, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 52p. (In German). Dep. CFSTI (U. S. Sales Only).

The interaction of infrared light with plasmas is described. Using lasers there exist as measureable effects light scattering, beam deviation, beam damping, phase shift and change of polarization; based on the available literature, the possible diagnostic methods are discussed. (auth)

5156 (SIT-2582-31) EXPERIMENTAL INVESTIGATION OF CUSPED CONTAINMENT GEOMETRIES, CHALICE. Semi-annual Report, March 1–August 31, 1969. Yevick, George J.; Harvey, Robin (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Contract AT(30-1)-2582. 71p. (SIT-240). Dep. CFSTI.

A Thompson scattering apparatus embodying several novel technical features was built and is ready for operation for the measurement of electron plasma temperature in the CHALICE experiment. New types of interferometric systems are also discussed with the aim of improving the sensitivity of density measurements over the standard Mach–Zehnder technique. The detection of soft x rays by a differential x-ray absorber apparatus will monitor the Thompson scattering experiment. Calculations aimed at simulating CHALICE by the computer technique PIC were initiated. (auth)

5157 PLASMA VELOCITY MEASUREMENTS BY ABEL UNFOLDING OF DOPPLER SHIFTS. Ahlborn, B.; Morris, R. N. (Univ. of British Columbia, Vancouver). J. Quant. Spectrosc. Radiative Transfer.; 9: 1519-25(Nov 1969).

It is possible to obtain the radial dependence of velocity for steady, cylindrically symmetric, axial plasma flow fields using a double-wedge spectroscopic technique. This method measures the accumulated Doppler shifts and line intensities without detailed knowledge of the spectral line profile. (auth)(UK)

5158 DIAGNOSTICS IN FIELD-FREE PLASMAS WITH MEDIUM-DISPERSION OPTICAL-SPECTROGRAPHIC AND SOURCE-MONITORING EQUIPMENT. II. A "CASE STUDY" EXPERIMENT. Hefferlin, Ray (McDonnell Douglas Corp., St. Louis). Progr. High Temp. Phys. Chem.; 3: 149-229(1969).

An argon, laminar-flow, atmospheric-exhaust, seeded plasma jet was used as a case study for the comparison of 11 spectroscopic diagnostic methods. The ultimate objective was to demonstrate acceptability for measurement of f-values. The methods: (1) tests for self-absorption; (2) electron densities from the GKS line-broadening theory; (3) excitation–ionization temperatures from absolute peaking functions and line intensities; (4) temperatures from Boltzmann plots; (5) particle densities from Boltzmann plots; (6) particle densities from the line intensity equation and from No. 3; (7) particle and electron densities from LTE calculations using No. 3 as input. Much of the information was in the form of radial distributions. The existence of more than one "temperature" at any one place in the plume was explored, and in order to obtain additional data, (8) densities from No. 6 were used in the line intensity equations to obtain "temperatures." The existence of this non–LTE was confirmed by (9) an energy balance calculation. Semi-quantitative information was obtained from (10) the continuum and from (11) radiation trapping. The material is presented not in the enumeration given above, but so as to follow the discussion of Hefferlin (1968), which can be considered the "literature search" for this experiment. Several tests for the LTE model exist in the literature (Griem, 1964) and these indicated that the source was marginally LTE. Recourse was then had to a model in which the hot core was imagined whipping about within a less-hot plasma, which in turn was surrounded by a cool boundary layer. Incomplete results from this model indicate that the results can be brought into harmony with each other and with the optically thin LTE model except for H I and Mn I. The model indicates that Boltzmann-graph excitation temperatures from a source with a radial temperature distribution will give various results depending primarily on the ionization potential of the specie, and that the specie density obtained from the graph intercept will always be low. It is suggested that this same model will provide criteria by which measurements without Abel inversion might lead to a knowledge of the temperature and density distributions in the plasma. 45 references. (auth)(UK)

5159 INTRODUCTION TO THE THEORY AND PRACTICE OF SPECTROSCOPIC DIAGNOSTICS OF HIGH-DENSITY PLASMA SOURCES OF AEROSPACE AND CHEMICAL SYNTHETIC INTEREST. Freeman, M. P. (American Cyananid Co., Stamford, Conn.). Progr. High Temp. Phys. Chem.; 3: 255-322 (1969).

The subject is discussed under the following headings; Introduction; spectroscopic measurement (definitions; measurements not dependent on equilibrium and/or composition assumptions; blackbody radiation; measurements depending on the assumption of thermodynamic equilibrium; absolute intensity measurements; relative intensity measurements; special methods for hydrogen); data aquisition (equipment requirements; dimensions of spectroscopy; the spectroscope—external optics, forming the spectrum, mounting, wavelength calibration; quantitative measurements—intensity standards, photographic recording, photoelectric recording); data reduction (spatial resolution—optically thin and radially symmetric source, mildly asymmetric data, plasma with self-absorption, numerical procedures; absolute intensity measurements—measurements relative to an intensity standard, absolute radiance of an intensity standard, interpretation of the molecular scale); evaluation of a temperature profile (the source; the standard; the spectrograph; external optics and mounting; the spectral line; calibration; emulsion, etc.; measurement—exposure, densitometry, radiance coefficient profile, correction for the far wings, number density of emitters, temperature evaluation). 77 references. (UK)

Kinetics (General)

5160 (AD–691470) BASIC PLASMA PROCESSES. Yearly Summary Technical Report, July 1, 1968–June 30, 1969. Phelps, A. V.; Chen, C. L. (Westinghouse Research Labs., Pittsburgh, Pa.). 25 Jul 1969. Contract Nonr-4725(00). 69p. CFSTI.

The resonance radiation emitted by thermally excited cesium vapor was observed at a temperature of 800°K and cesium densities between 3.7 and 37×10^{16} atoms/cc. The spectral distribution of the radiation shows the line reversal effects expected for a finite rate of production of excited atoms. Measurements of the magnitude and wavelength dependence of the specular reflection of light in the vicinity of the resonance line have been extended to cesium densities near 6×10^{17} atom/cc and support the Taylor–Langmuir formula for the equilibrium cesium vapor pressure rather than the recent results of Volyak, Vinogradev and Anisemov. The theoretical studies of the backscattering of resonance radiation have been extended to include the effects of the nonradiative transport of excited resonance atoms to boundaries, such as the windows of the experimental cell. The theory was also extended to include illumination by narrow line sources, such as the resonance line source used in the studies of mercury vapor by Hansen and Webb. (auth) (USGRDR)

Kinetics (Experimental)

Refer also to abstract 5183.

5161 (IPP–1/98) MULTICHANNEL ENERGY ANALYSIS OF THE ION FLUX FROM A THETA PINCH. Becker, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 43p. (In German). Dep. CFSTI (U. S. Sales Only).

A new 10-channel energy spectrometer ($E = 1$ to 10 keV, channel width 200 eV) is used to analyze the ion flux parallel to the axis of a linear theta pinch, Isar III ($p_0 = 10$ to 30 mtorr D_2). Time resolved energy spectra are obtained from each discharge. There is experimental evidence that neutral gas, electrons, and magnetic fields influence the ion flux in quite a different way than hitherto supposed. They distort the distribution especially at the lower energy limit of the instrument range and yield measured ion fluxes that are too small by more than a factor of 10. The measured energy spectra ($E \leq 15$ keV) are wide and without ion groups. With 10 mtorr D_2 $dn/dE \propto \{\exp - E/\bar{E}\}$ for $E \geq 3$ keV and $\bar{E} \approx 1$ keV. For 10, 20, and 30 mtorr $\bar{E}$ is about equal to the kT obtained from the neutron flux. The time behavior of the neutron flux and ion flux in the range 1 to 10 keV is correlated. The results of the measurements are incompatible with relaxation due to Coulomb collisions. What is probably involved is an anomalously fast relaxation caused by a microinstability (with 10 mtorr already before $t = 1$ μsec; at $t = 0$ the main discharge begins). The time variations of the measured ion fluxes can be explained for all E of the instrument range. After the end of the anomalous relaxation the end loss, now being due to distant collisions, continues only for slow ions. The loss of energetic ions decreases sooner with increasing energy. The growing distortion of the E-distribution with small E leads to a second microinstability at $t \approx 5$ μsec, which allows mainly the energetic ions to escape (probably a loss-cone type). (auth)

5162 (NP–18065) ROLE OF REPEATED DISCHARGES IN Z-PINCH DYNAMICS. Kvartskhava, I. F.; Matveev, Yu. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Previous experimental studies of linear Z pinches revealed clearly expressed current–voltage curve breakages, which were named the "peculiarities." Analyses of the current and voltage oscillograms and results of experiments indicated a direct relationship between the observed "peculiarities" and repeated charge ignition along the walls of the discharge chamber appearing as a result of the induction. The obtained high-speed streak photographs, distribution curves of the current density along the chamber radius (corresponding to the repeating breakdown time), and the oscillogram of the signal from the magnetic probe placed inside the plasma shell also confirmed the above conclusion. The repeated discharge ignition, appearing in the early stages, limited significantly the rate of incoming energy in the pinch and interfered with plasma heating. (tr-auth)

5163 AMPLIFICATION REGIONS OF A uhf SIGNAL FROM A BEAM–PLASMA INTERACTION. Pham Tu Manh (CNRS, Orsay, France). Compt. Rend., Ser. B; 269: 351-4(1 Sep 1969). (In French).

The experimental results concerning the amplification of a uhf signal from the interaction of an electron beam and a plasma are in good agreement with the theory: the frequency regions where amplification is possible could be precise. Other interesting regions not provided for by the theory were also found. (tr-auth)

5164 ROTATION IN IMPLOSION PHASE OF A THETA PINCH. Benford, James Nelson. San Diego, Calif.; Univ. of California (1969). 165p.

Thesis.

The radial variation of the rotational velocity of the current sheet in the implosion phase of a theta pinch has been measured. Measurements of fields and pressure gradients allowed the determination of ion azimuthal velocity from the radial component of Ohm's Law. The axial magnetic field was obtained from a pickup coil and probing of the radial electric field was accomplished with a double floating probe. Electric field data were corrected for electron temperature differences between the probe electrodes. Thomson scattering of a laser beam at 90° was used to measure the radial distribution of electron density and temperature. An estimate of ion temperature was obtained from observation of the unresolved ion feature. (TSS) (Diss. Abstr. Int., B)

5165 TIME-CORRELATED STUDY OF THE Z-PINCH DISCHARGE IN HELIUM. Dimoff, Kenneth. Vancouver, B. C.; Univ. of British Columbia (1968).

Thesis.

The structure in the collapse stage of a linear Z-pinch discharge in helium was studied by optical methods. Observations with a framing camera, rotating mirror spectrograph, and monochromator were correlated with magnetic field and current distributions determined by Tam (1967). (TSS) (Diss. Abstr. Int., B)

Kinetics (Theoretical)

5166 DIELECTRIC CONSTANT OF WEAK INHOMOGENEOUS PLASMA WITH ALMOST MONOENERGETIC COMPONENT. Belikov, V. S.; Kolesnichenko, Ya. I.; Oraevskii, V. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 1242-6(Aug. 1969). (In Russian).

The dielectric constant tensor is calculated of weakly inhomogeneous plasma having an almost monoenergetic component. The distribution function of particles produced due to thermonuclear reactions was used as an almost monoenergetic distribution function. (auth)

5167 RECOMBINATION OF ALKALI PLASMA IONS ON HOT TUNGSTEN SURFACES. Motley, R. W.; Jassby, D. L. (Princeton Univ., N. J.). Phys. Rev.; 187: 314-20(5 Nov 1969).

The rate of surface recombination of cesium and potassium plasma ions on the hot tungsten end plates of a Q machine was measured with a Langmuir–Taylor detector. Good agreement of the measurements with the equilibrium theory of electrostatic confinement is found under conditions in which the plasma potential is not highly negative or positive ($|V| < 2kT/e$). Corrections to the equilibrium theory for ion heating (highly negative plasma) and ion drifts (highly positive plasma) bring theory into good agreement with experiment over a range in density of 2×10^9 to 2×10^{12} cm^{-3}. (auth)

5168 CHARGE-DENSITY FLUCTUATIONS IN SPECTRAL LINE BROADENING. Dufty, James W. (Univ. of Florida, Gainesville). Phys. Rev.; 187: 305-13(5 Nov 1969).

A method for describing the spectral line shapes for radiating atoms immersed in a plasma is developed without neglecting ion–electron interaction and without the static-ion assumption. Both the line center and the wings are investigated, and connection with previous work in these regions is made. (auth)

5169 ELECTRIC CONDUCTIVITY OF A FULLY IONIZED PLASMA IN A STRONG MAGNETIC FIELD. Daybelge, Umur (Teknik Univ., Istanbul). Phys. Rev.; 187: 296-304(5 Nov 1969).

A method of obtaining exact transport coefficients of a plasma in a strong magnetic field is presented. The method is based on Kihara and Aono's unified theory. As an application of the method, the electrical conductivity of a fully ionized plasma in a strong magnetic field is calculated. The departure from the ordinary theory is expressed by a function χ, which depends on the ratio of the Debye length to the electron gyroradius. Numerical values of χ are given. (auth)

5170 ELECTRON DRIFT VELOCITIES IN A MODERATE AND IN A STRONG CROSSED MAGNETIC FIELD. Heylen, A. E. D. (Univ. of Leeds, Eng.); Bunting, K. A. Int. J. Electron.; 27: 11-12(Jul 1969).

From energy balance considerations in the presence and absence of a crossed magnetic field and without assuming an a priori constant electron collision frequency, an equivalent reduced electric field concept is evolved which reduces to the more familiar equivalent pressure concept when the electric field is kept constant. Using the concept and assuming a Maxwellian electron energy distribution, calculation of the electron transverse and perpendicular drift velocity and their ratio tan θ is extended to a moderate and strong magnetic field for hydrogen gas. The results are in good agreement with experimental data in the electron energy range where ionization by collision occurs. It is shown numerically that average electron collision frequency values, derived from the various transport coefficients, inherently vary widely. If the average electron collision frequency is derived from a given transport coefficient, then its value still depends on the magnitude of the reduced magnetic field even when the average electron energy is kept constant. For hydrogen the variation is least (20%) in the above energy range. A new and improved method for measuring the electron collision frequency is given, based upon the equivalent reduced electric field concept. (auth)(UK)

5171 CONDUCTION, CONVECTION, AND RADIATION IN A NONISOTHERMAL HYDROGEN PLASMA. Mandell, D. A. (Washington State Univ., Pullman). J. Quant. Spectrosc. Radiative Transfer.; 9: 1553-61(Nov 1969).

The object of the work described was to study the mechanism of radiation heat transfer, combined with conduction and convection heat transfer, in a nonisothermal hydrogen plasma. In order to illustrate the mechanism of radiation in a plasma, the problem of fully developed laminar flow and heat transfer between black parallel boundaries with a constant wall heat flux is considered. The assumptions of linearized radiation and local thermodynamic equilibrium are made. The results are presented in terms of dimensionless bulk gas temperatures. The influence of line radiation compared to continuum radiation is investigated. Optically thin results, optically thick results, and results obtained from a nongray differential approximation are compared to the results obtained from the general equation. The results show that the optically thin solution and also the differential approximation results greatly over-estimate the influence of radiation. The optically thick solution does not appear to be useful since it gives the result that the bulk temperature is approximately equal to the wall temperature. For lower pressures, the spectral lines have a significant influence on the dimensionless bulk temperature, but at higher pressures the line effect becomes negligible. (auth)(UK)

5172 RADIATION FROM A CHARGE MOVING UNIFORMLY IN INHOMOGENEOUS MAGNETOACTIVE MEDIA. Lizogub, P. P. (Moscow State Teacher's Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1311-16(1969). (In Russian).

The radiation from a charge moving in a magnetoactive medium, the properties of which are described by two Hermitian tensors with variable components, is considered by means of Fourier and perturbation methods. The expressions are derived for the radiation energy losses and the spectrum of radiation from a charge moving in a plasma placed in the external spatially inhomogeneous periodic weak magnetic field. (auth)

5173 TEMPERATURE RELAXATION IN THERMAL BOUNDARY LAYERS OF HIGHLY IONIZED GASES. Wei, Hsin Yi. San Diego, Calif.; Univ. of California (1968). 125p.

Thesis.

The problem of electron–ion temperature relaxation when two semi-infinite, nonmagnetized plasmas at different initial temperatures were suddenly brought into thermal contact under constant pressure is first investigated using the two-fluid model. No current is assumed to flow across the interface, and charge separation is considered only to the extent of a simple correction on effective thermal conductivity (i.e., no plasma oscillation). Viscous stresses associated with induced fluid motion are also neglected. Asymptotic solution for long-time after-thermal contact is shown to be identical to that in a single-temperature plasma, with effective thermal conductivity equal to approximately $[1 + (3Me/Mi)^{1/2}]$ times the local electron thermal conductivity. For a time scale shorter than or comparable to the mean electron–ion collisional energy transfer time t_{ei}, self-similar solution is obtained in the form of a double series in ascending powers of the nondimensional time $t = t/t_{ei}$ and of the initial temperature difference parameter $\epsilon = (T_2 - T_1)/(T_2 + T_1)$. It is found that the induced pressure is quite large at early times, suggesting that thermal shock could be a significant source of plasma wave excitation in certain nonsteady problems. Following the interface problem, the electron–ion temperature relaxation in a highly ionized gas in sudden contact with a cold wall is investigated using a three-fluid model. The wall is considered to be perfectly catalytic for electron–ion surface recombination but the plasma density is assumed to be too low for volume recombination to be important. The electrostatic sheath potential at the wall is assumed to be in quasi equilibrium with a time-dependent local electron temperature, while the ions and neutral atoms at the edge of the sheath are assumed to relax to the wall temperature immediately. Based upon the thin-sheath approximation, the rate of diffusion of ion pairs toward the wall and counter diffusion of neutral atoms are assumed to be regulated by ambipolar diffusion. Because of the competition between diffusion and collisional energy transfer rates it is found necessary to seek solution in the form of two separate time series, i.e., one in ascending integral powers of time to account for collisional energy transfer and the other in ascending half powers of time to account for diffusion. Sample solution is given for an argon plasma under conditions typical of that encountered in end-wall shock reflection experiments. (Diss. Abstr.)

Production

5174 (AD-691818) STEADY STATE PLASMA GENERATED BY STRONG, HIGH FREQUENCY FIELDS. Report for September-December 1968. Epstein, Melvin (Aerospace Corp., El Segundo, Calif.). 1 Aug 1969. Contract F04701-69-C-0066. 31p. (TR-66(5240-20)-2; SAMSO-TR-69-227). CFSTI.

Supersedes TR-200(4240-20)-8.

Steady-state plasma generated by a strong, high-frequency electromagnetic wave normally incident on a slab of gas is analyzed, and the electron density distribution in the slab, as well as the propagation characteristics of the discharge, are described as functions of the strength of the incident signal. The analysis is based on the simultaneous solution of the electron diffusion equation and Maxwell's equations, including the transition from free to ambipolar diffusion. The results provide predictions of the fields required to produce breakdown, the fields required to maintain the discharge, and the power transmitted through the slab as a function of the strength of the incident field. (auth) (USGRDR)

5175 (COO-1776-5) POROUS IONIZERS AS IMPROVED PLASMA SOURCES. Final Report. Dewey, C. Forbes Jr. (Colorado Univ., Boulder. Dept. of Aerospace Engineering Sciences). [1969]. Contract AT(11-1)-1776. 17p. Dep. CFSTI.

Work performed in developing porous ionizers as improved plasma sources is summarized, and articles submitted for journal publication under the contract are listed. Construction of successful emitters proved very difficult, but development problems were solved, and it appears feasible to construct successful units based on the fabrication techniques developed. A detailed description of the final unit completed under this contract is included. (auth)

5176 (IPP-3/95) HYDROGEN PLASMA PRODUCTION BY GIANT PULSE LASERS: A THEORETICAL STUDY. Mulser, P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

The problem of interaction of an intense laser beam with solid hydrogen is theoretically investigated in a one-dimensional plane geometry. The time-dependent distributions of density, temperature, and velocity of the produced plasma, as well as those of the solid are found by numerical solution of the hydrodynamic equations for various laser powers. The maximum temperature can be approximately expressed in closed form as a function of the laser intensity and time. The calculations allow for the influence of thermal conduction and viscosity. At laser intensities above 1.8×10^{11} W/cm^2, the frequency of the plasma rises above that of the laser in the transition sheath between the hot plasma and the cold solid compressed in the ratio 1:4. The problem of the absorption and reflection of laser radiation in this region is investigated. (auth)

5177 (IPP-3/96) EXPERIMENTAL INVESTIGATION OF PLASMA PRODUCTION BY IRRADIATION SOLID HYDROGEN FOILS WITH AN INTENSE PULSE LASER. Sigel, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 59p. (In German). Dep. CFSTI (U. S. Sales Only).

Foils of solid hydrogen were irradiated with a giant pulse ruby laser, the intensity in the focal spot being 10^{12} W/cm^2 during 18 nsec (half width of laser pulse). The process of plasma formation and expansion was investigated by time-resolved absorption measurements, by streak and framing photography, by holographic interferometry and by time-of-flight and charge-collection measurements. Atoms were found to be vaporized and ejected as a hot plasma from the foil, the mean kinetic energy of the ions being 200 eV. The bulk of the plasma was ejected towards the laser, though foils up to a thickness of 1 mm were pierced by the laser beam before the end of the pulse. The observations suggest that the process of plasma production takes place in a strongly absorbing front which moves from the front to the rear of the foil with a velocity of 3×10^{16} cm/sec. The observations are compared with the well-known theoretical results obtained in a plane, one-dimensional geometry. In addition, the influence of the focusing of the laser beam on the structure of the shock front is treated in a so-called piston model. As this modification allows the observations to be readily understood, it is concluded that the underlying one-dimensional approach is confirmed by the experiment. (auth)

Stability

5178 (IPP-6/75) EXISTENCE OF TOROIDAL MAGNETOHYDROSTATIC EQUILIBRIA WITHOUT ROTATIONAL TRANSFORM. Lortz, Dietrich (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 26p. (In German). Dep. CFSTI (U. S. Sales Only).

The magnetohydrostatic boundary-value problem is investigated for a toroidal boundary surface T, which is symmetric with respect to a plane, but which need not be continuously symmetric. The existence of an equilibrium solution is proved for the boundary condition that the magnetic field $\underline{B}$ be tangential at T. The pressure as a sufficiently smooth function and the azimuthal magnetic flux can be chosen arbitrarily. (auth)

5179 (IPP-6/76) LOW FREQUENCY INTERCHANGES. Spies, Guenther Otto (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 34p. Dep. CFSTI (U. S. Sales Only).

Unstable low-frequency interchanges, i.e., electrostatic modes with growth rates of the order of the guiding-center drift frequencies and thus conserving the longitudinal adiabatic invariant j, are shown to exist in a wide class of self-consistent low-β guiding-center equilibria. This class is defined by some restrictions, the most important of which are symmetry, vanishing of the electric field, and stability on the faster time scale of the longitudinal guiding center motion. Open-ended as well as toroidal configurations, with or without a rotational transform, and arbitrarily anisotropic distribution functions are admitted. Some relationships to the MHD description are derived for the subclass of equilibria having isotropic distribution functions. The well-known interchange stability criterion of the guiding-center theory, for example, is shown to be identical with the well-known V'' criterion of the MHD theory. Since low-frequency interchange stability (j conserved) turns out to be a more restrictive requirement than interchange stability (j violated), the confusion arising from earlier work on this subject is removed. The present theory is a generalization to a much wider class of equilibria of Rosenbluth's theory of the trapping instability in axisymmetric multipoles containing isotropic Maxwellians. This generalization shows that the stability condition, as far as it concerns the confining magnetic field, is relaxed by allowing for anisotropy. (auth)

5180 FEEDBACK DESTABILIZATION OF MIRROR MACHINES BY MICROINSTABILITIES. Clarke, J. F. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 23: 1215-18(Nov. 24, 1969).

Electron loss from the magnetic mirrors in the DCX-2 experiments is shown to lead to a coupling of a gyrofrequency instability and a normally stable ∇B drift wave. This coupling produces a new instability near the drift frequency and can lead to cross-field particle transport. The effect is predicted to occur in minimum-B geometries and may be the mechanism responsible for the particle loss in several experiments. (auth)

Thermonuclear Processes

Refer also to abstracts 4505 and 5154.

5181 (COO-1726-39) TECHNICAL REPORT [ON PLASMA PHYSICS], FEBRUARY 1, 1969-JANUARY 1970. (Wisconsin Univ., Madison. Dept. of Physics). 18p. Dep. CFSTI.

Research progress on the following topics is discussed: (1) levitated octupole construction, (2) studies with the original octupole, (3) theoretical studies, (4) plasma transport toward hoops, (5) superconducting tests, (6) microwave studies and the Fabry-Perot systems, (7) feasibility studies, and (8) gun studies and moving plasma cloud studies. (M.O.W.)

5182 (IPP-3/99) DIAPHRAGM SHOCK TUBE FOR PLASMA EXPERIMENTS. Muntenbruch, H.; Nett, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 60p. (In German). Dep. CFSTI (U. S. Sales Only).

A diaphragm shock tube is described. The solutions to the technical problems entailed in constructing the shock tube are described. First the preliminary considerations underlying the dimensioning of the tube are briefly sketched and then its mechanical construction is described. This involves problems relating to the high-pressure, low-pressure, and buffer sections. The diaphragm problem and the associated triggering problem are also dealt with. Later the gas supply and vacuum systems are described, these having a major influence on the experimental utilization of the tube. The question of operational safety is also touched on. Finally, the installation and operation of the tube are reported, a "routine" shot being documented in table form. Various special technical problems are treated in detail in the appendices. (auth)

5183 CHARACTERISTICS OF THE SCYLLA-IA THETA PINCH WITH CROWBAR. Finlayson, Val A. Salt Lake City; Univ. of Utah (1969). 126p.

Thesis.

The plasma and machine characteristics of the 96-kJ Scylla IA theta pinch are described. In contrast to previous theta pinches which employ single-turn coils for magnetic compression, Scylla IA has a two half-turn coil system that attains a voltage-doubling effect. This produces a higher electric field $E_\theta = 1.33$ kV/cm. Energy is stored in two 50-kV primary-capacitor banks consisting of 18 low-inductance 2.1-μF capacitors each. The energy is transferred to the half-turn coil system through 216 parallel low-inductance coaxial cables. The magnetic field rises to peak value in 1.7 μsec, at which time it is crowbarred by a fast metal-to-metal solid-dielectric shorting switch. The switch closes in 5.5 μsec with a shot-to-shot variation in closing time of ±0.05 μsec. With 48-kV operation of the primary bank, the switch carries approximately 1.8 MA with a 1/e-decay time constant of better than 800 μsec. The Scylla IA plasma β, density, and temperature are obtained from three coordinated plasma-diagnostic experiments consisting of (1) a differential magnetic loop-probe measurement that determines total flux excluded by the plasma, (2) side-on measurement of the profile of light emitted by the plasma that yields the relative density and (3) a gas-laser-interferometer measurement that gives the absolute density integrated through the plasma. In the low-pressure regime ($P_{\text{initial}} = 24$ mtorr), typical measured values are $\beta = 0.67 \pm 0.10$ and $n_e = n_i = 3 \times 10^{16}$ cm^{-3} on axis and $T = T_i + T_e = 3$ keV. Because of its faster initial compression of plasma, Scylla IA is well suited for studying the initial implosion phase and shock heating in a theta pinch. (Diss. Abstr.)

Wave Phenomena

5184 (AD-691428) SCATTERING OF HF RADIO WAVES BY A SPHERICAL ELECTRON CLOUD. Physical Sciences Research Papers No. 384. Klein, Milton M.; Mabee, Richard S. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Jun 1969. 31p. (AFCRL-69-261). CFSTI.

Numerical and analytic solutions in the ray optics region were obtained for the scattering of hf radio waves by a spherical electron cloud with a Gaussian distribution of electron density in the radial direction. The results show that a highly overdense or hard cloud has a wide range of backscatter angles for which the cross section is almost constant with a value close to that of an equivalent conducting sphere (critical radius size). A slightly overdense or soft sphere has a much narrower range of almost constant cross section whose value is proportional to the fourth power of the critical radius and considerably below that of an equivalent conducting sphere. In the region of forward scatter all spheres have essentially the same cross section independent of hardness. For underdense spheres the cross section is generally the same as that characteristic of forward scattering except in the region of maximum deflection where the cross section increases very sharply. It is found that when an underdense sphere becomes critical the maximum deflection is 90°, whereas an overdense sphere retains its maximum deflection of 180° at the critical density. For overdense spheres the analytic results are in good agreement with those obtained numerically, but for underdense spheres are not in good agreement at the higher electron densities. (auth) (USGRDR)

5185 (AD-691883) LINEAR AND NONLINEAR THEORY OF GRID EXCITATION OF LOW-FREQUENCY WAVES IN A PLASMA. Report No. R-51. Johnston, George L. (California Univ., Los Angeles. Plasma Physics Group). Jul 1969. Contracts Nonr-4756(01); AT(11-1)-34. 36p. CFSTI.

The steady-state excitation of longitudinal waves by a pair of idealized grids immersed in a collisionless plasma and driven at a frequency small compared with the ion plasma frequency is investigated theoretically. In linear theory the Fourier-inversion integral which determines the spatial behavior of the potential in the plasma is expressed as a sum of two integrals which embody the interactions of phase-velocity components of the wave with ions and electrons. An appropriate choice of the deformed contour of integration permits evaluation of the response as the sum of the residue of the dominant "ion-acoustic" pole and of the two branch-cut integrals. A perturbation-series expansion of the potential and the species distribution functions in the (nonlinear) Vlasov equation yields a hierarchy of equations. In each order the equations are linear in the perturbation quantities of that order and have driving terms composed of quadratic combinations of lower-order quantities. (auth) (USGRDR)

5186 (CONF-690619-16) TRANSFORMATION AND ABSORPTION OF HIGH FREQUENCY WAVES IN PLASMA. Golant, V. E.; Piliya, A. D. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1969. 10p. Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

Studies are discussed for electromagnetic wave absorption in the frequency range between electron cyclotron and the upper and lower hybrid frequencies. (M.O.W.)

5187 VACUUM BOUNDARY CONDITIONS FOR HELICON WAVES IN A CYLINDRICAL PLASMA. Davies, B. (Flinders Univ. of South Australia, Bedford Park). J. Phys., A (London): 2: 717-19(Nov 1969).

Helicon propagation in a cylindrical resistive plasma with vacuum boundary conditions is considered. It is shown that the wave fields (which are assumed to be continuous at the boundary) develop rapid variations as $\eta \rightarrow 0$, which can be represented physically by surface currents and a surface dipole layer. The contribution of the dipole layer to n. [E] clears up a difficulty in a recent paper by Francey and Gates (1968). (auth) (UK)

5188 SURFACE WAVE ABSORPTION IN A PLASMA WAVEGUIDE DUE TO PLASMA RESONANCE IN A TRANSIENT LAYER. Demchenko, V. V.; Dolgopolov, V. V.; Stepanov, K. N. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1317-25 (1969). (In Russian).

The attenuation of surface waves propagating in homogeneous plasma cylinder caused by the plasma resonance in a narrow transient layer between the plasma and vacuum is investigated. The dispersion equations are obtained, taking account of the damping in the transient layer. It is shown that the attenuation coefficient, caused by the plasma resonance, is proportional to the axial wave number multiplied by the ratio of the thickness of the transient layer to the radius of the plasma cylinder or to the wavelength, if it is considerably less than the plasma cylinder radius. Therefore, in the inhomogeneous (over the radius) plasma cylinder when the transient layer thickness is of the order of the cylinder radius, the attenuation coefficient is of the order of the axial wave number, i.e., the propagation of waves is impossible due to the strong attenuation. An exception is the case of axially symmetric oscillations with the wavelength considerably less than the plasma cylinder radius. (auth)

5189 COUPLING OF ELECTROMAGNETIC WAVES TO A PLASMA-FILLED WAVEGUIDE. Gupta, K. C. (Indian Inst. of Tech., Kunpar); Singh, A. Int. J. Electron.; 26: 595-8 (Jun 1969).

Excitation of slow electromagnetic waves in a waveguide filled with magnetized plasma, using a ring of magnetic current placed along a gap in the waveguide wall, is analyzed. It is pointed out that coupling of the electromagnetic power may be enhanced by a localized increase of plasma density near the coupler. (auth)(UK)

5190 THE VELOCITY OF SOUND AND THE ELECTRON TEMPERATURE IN A LORENTZ PLASMA. Saxena, A. P.; Gaur, S. C. (Government Coll. of Engineering and Tech., Raipur, India). Int. J. Electron.; 27: 13-22(Jul 1969).

The electron temperature and the velocity of sound waves in a Lorentz plasma were determined by transmitting sonic signals in the range 4 to 40 kc. It was observed that although the reflections of the sound waves at the plasma-air interfaces occur when the relative characteristic impedance of plasma with respect to air exceeds unity, the reflected or transmitted pressure amplitudes do not change appreciably until the relative characteristic impedance exceeds the value $(Z + 1)^{1/2}$, where Z is the charge of the ion. Thus the critical value of the relative characteristic impedance above which the attenuation of the sound waves becomes sharp depends upon the nature of the gas and the ionic charge. This method is also useful for exploring the pre-glow/Townsend discharge condition of the ionized media. The plasma parameters may be measured even in very weak ionizations where other existing techniques, viz., the microwave/ultrasonic probing or spectroscopic methods, are not suited. This sonic probe technique was employed for the first time in the field of investigation. (auth)(UK)

5191 WAVE FRONT AND SIGNAL VELOCITIES OF A rf WAVE IN PLASMA IN THE REGION OF BACKWARD WAVES. Nandedkar, D. P.; Bhagavat, G. K. (Indian Inst. of Tech., Bombay). Int. J. Electron.; 27: 31-47(Jul 1969).

In previous papers (Bhagavat and Nandedkar, 1968 and 1969) rf energy transport in the vicinity of damped oscillations in plasma, where absorption of rf energy is maximum, was investigated. Backward waves were shown to exist in the region of anomalous dispersion of the plasma. The absorbed rf energy in the region of backward waves appears as noise. In this paper, wavefront and signal velocities of a rf wave in plasma, in the region of backward waves, are analyzed. (auth)(UK)

5192 EXCITATION AND DAMPING OF COLLISIONAL DRIFT WAVES. Rowberg, Richard Even. Los Angeles; Univ. of California (1969). 94p.

Thesis.

A method of external excitation of density-gradient drift waves in a normally stable collision-dominated plasma is presented, whereby it is possible to study the linear behavior of such waves. By limiting the excited wave to amplitudes such that $e\phi_1/kT < 0.1$, it was possible to study drift wave behavior in a regime where nonlinear processes are negligible. This represents a marked advance over previous drift wave investigations which were done in the unstable regime where nonlinear saturation effects influenced the behavior of the oscillations. To perform the experiment, the plasma of a Q device is stabilized against drift waves by a combination of viscous and end-plate damping. The wave is then driven by applying a signal to a grid inserted into the plasma. By observing the resonant frequency of the driving signal, the real frequencies of the various modes can be identified. Removing the excitation signal causes the wave to damp out at a rate determined by the end plate damping rate (ω_D) and the linear growth rate of the drift wave (ω_g). The measured damping (ω_I) will then determine the growth rate through the expression $\omega_I = \omega_D - \omega_g$. Finally, the phase angle between the density and potential fluctuations of the wave is measured. The following results are obtained in accord with the linear theory: (1) The real and imaginary frequencies vary with magnetic field and plasma column length as predicted showing the strong stabilizing effect of ion viscosity. (2) The phase angle between the density and potential perturbations is such that n_1 leads ϕ_1 for positive growth rates and this angle is observed to vary with magnetic field in the same manner as the growth rate. (3) The axial wavelength of the drift wave varies with the sheath condition at the end plates of the Q device. (TSS) (Diss. Abstr.)

5193 INVARIANT IMBEDDING TECHNIQUES USED TO SOLVE WAVE PROPAGATION PROBLEMS IN HORIZIONTALLY STRATIFIED PLASMA MEDIA. Davies, Hugh Alfred. Nashville; Vanderbilt Univ. (1969).

Thesis.

A different approach is taken to the theoretical study of electromagnetic wave propagation in a horizontally stratified plasma medium. The equations which describe the system are arrived at through magneto-ionic theory and represent a set of two second-order coupled differential equations. The restraints upon these equations are such that two-point boundary conditions must be satisfied. A numerical scheme is developed and applied to the describing differential equations. This numerical method possesses advantages which make it possible to solve systems of second-order coupled differential equations without initial knowledge of the boundary conditions. In this sense then, the solution is general. The numerical technique forms a transformation which operates upon the boundary conditions to yield a specific solution. Utilizing the properties of the numerical method the boundary conditions are calculated for the system of describing differential equations. These calculations are made for the specific case of a plane electromagnetic wave impinging upon one boundary of the horizontally stratified plasma medium. The dependent variables of the describing differential equations represent total field quantities in specific directions. The describing differential equations are solved under a number of selected conditions. The cases computed for which the incident energy was totally reflected are analyzed. Under this condition energy is seen to be coupled from the extraordinary wave into the ordinary wave. The net energy transfer from the extraordinary to the ordinary wave is a function of the angle which the incident wave makes with respect to the direction of the steady magnetic field. Many cases show that all energy possessed by the extraordinary wave is transferred into the ordinary wave at a particular angle of incidence. Polarization of the ordinary and extraordinary waves is also of interest. In general the polarizations of the ordinary and extraordinary waves are elliptical. The data obtained show the existence of a pseudo-Brewster angle. At this particular angle of incidence the polarization of each of the reflected waves becomes linear. For larger angles of incidence the sense of polarization changes. That is, the reflected wave polarization changes from right-hand elliptical to left-hand elliptical and vice versa. In the observed cases the pseudo-Brewster angle coincides with the angle of incidence at which the maximum coupling between the ordinary and extraordinary waves occurs. (TSS) (Diss. Abstr.)

5194 WAVE PROPAGATION NEAR THE COUPLING POINT IN THIN SLABS OF INHOMOGENEOUS WARM PLASMA. Le Vine, David Michael. Ann Arbor, Mich.; Univ. of Michigan (1968). 117p.

Thesis.

The waves that propagate near the coupling point in a slab of inhomogeneous warm plasma are studied. The slab is assumed to have density variations only in the direction normal to the plane of the slab and the waves are assumed to be excited by obliquely incident plane waves. The primary objectives of the analysis are to obtain a solution for the waves which propagate near the coupling point in a warm plasma, to determine whether or not singularities exist in the electric field at the coupling point, and to critically evaluate the applicability of the cold plasma model there. "Coupling point" is the name given to points at which plasma frequency and the frequency of oscillation are equal. This name is chosen because coupling between modes of propagation is most predominant in the slabs of warm plasma which are being considered in this treatise whenever $\omega = \omega_p$. In the slab problem the locus of all coupling points is a plane parallel to the slab surface. A hydrodynamic model with a scalar pressure is assumed for the warm plasma and loss is taken into account by means of an effective collision frequency. The plasma parameters are chosen to be roughly in accord with those encountered in reentry plasmas. The case of large density variations is of particular interest. The problem is reduced to the solution of a pair of coupled, ordinary, linear differential equations which have a regular singular point at the origin. The solution is effected by a perturbation technique which is shown to lead to an exact solution. Convergence of the series involved is proven and the zero temperature limit of the solutions is investigated. It is shown that the singularities which occur in the lossless cold plasma do not occur in the warm plasma. In the case of small loss and/or large density gradients, it is shown that the cold plasma model does not predict the proper dependence on the collision frequency and density gradient. The conclusion reached is that near the coupling point the cold plasma is an inadequate model. In order to have a useful model available in the vicinity of the coupling point, the solutions obtained in this treatise are used to develop a scattering matrix for plasma slabs which have linear density gradients. (Diss. Abstr.)

Shielding

Refer also to abstracts 5273, 5371, and 5555.

5195 (N-69-33416) INVESTIGATION OF BREMSSTRAHLUNG PRODUCTION IN SPACECRAFT MATERIALS. Dance, W. E.; Rainwater, W. J. (Ling-Temco-Vought, Inc., Dallas, Tex.). July 1969. Contract NAS1-7772. 215p. (NASA-CR-1377). CFSTI.

Bremsstrahlung spectra resulting from bombardment of typical spacecraft materials by monoenergetic electrons were experimentally determined in the electron energy range 0.5 to 2.5 MeV. Spectral measurements were made for five angles of electron incidence using a Na(Tl) spectrometer. Integration of the spectra over all possible angles of incidence, with subsequent conversion of the result to dose, yielded for the case of a spherical shell, the bremsstrahlung dose spectra at each electron energy due to a unit omnidirectional flux of electrons. Types of target materials investigated are: (1) solid alloy slabs, (2) laminated alloys, and (3) ablative materials backed by alloyed honeycomb structures. Slab thicknesses of the alloys Ti 6Al 4V, Al 7075-T6, and Stainless 321 were chosen so as to stop 2.5 MeV electrons. Bremsstrahlung dose values inside spherical shells of the target materials were determined, assuming the omnidirectional electron environment found in synchronous orbits. (auth) (STAR)

5196 (WAPD-TM-835) ASPIS: A PROGRAM TO COMPUTE PLANE ISOTROPIC, MONODIRECTIONAL AND SLANT SOURCE GAMMA RAY BUILDUP FACTORS IN LAMINAR GEOMETRY. Lois, Lambros (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct 1969. Contract AT-11-1-GEN-14. 42p. Dep. CFSTI.

ASPIS is a FORTRAN program for the CDC-6600 that computes gamma-ray buildup factors for multilaminar slab geometry for plane isotropic, monodirectional and slant sources. This program is a modification of LETO, which utilizes double range Legendre polynomial expansion and the energy group concept. The unscattered source is analytically computed throughout the shield. (auth)

5197 REFLECTION OF ^{60}Co GAMMA RAYS FROM CONCRETE. Baran, J. A.; Faw, R. E.; Kimel, W. R. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 75: 141-8(1969).

Differential dose albedos are reported for reflection of ^{60}Co gamma rays from concrete. Data are reported for 5 polar angles of incidence, 3 polar angles of reflection and azimuthal angles of reflection from 0° to 158°. Total scattering angles varied from 33° to 155°. Measurements were made using a 3" × 3" NaI(Tl) scintillator in a lead collimator with a 0.011 sterad aperture. Pulse-height spectra were accumulated in a 400-channel pulse-height analyzer. Data analyses were accomplished using an experimentally determined response matrix with 25 unequal energy intervals over the range 20–1200 keV. (auth)

Solid-State Physics

Refer also to abstract 4209.

Radiation Effects

Refer also to abstract 4823.

5198 RADIATION-INDUCED PARAMAGNETIC STATES OF SOME INTRINSIC DEFECTS IN GeO_2 GLASSES AND CRYSTALS. Purcell, T.; Weeks, R. A. (Oak Ridge National Lab., Tenn.). Phys. Chem. Glasses; 10: 198-208(5 Oct 1969).

Radiation-induced paramagnetic states of some intrinsic defects in pure GeO_2 glasses, in GeO_2 glasses with added alkali oxide (M_2O/GeO_2 0.003, 0.03, and 0.3), and in crystals of GeO_2 were investigated by ESR techniques. The ESR measurements were made at 10 GHz and at 300° or 77°K prior to warmup following electron, reactor, and γ irradiations at temperatures ranging from 77 to 350°K. The irradiated glasses displayed three distinct ESR spectra. The spectrum of γ-irradiated polycrystalline tetragonal GeO_2 was composed of a single resonance. After reactor irradiation, two additional signals were detected. A comparison of spectra observed in the glasses and polycrystalline tetragonal GeO_2 with computed spectra gave good agreement for the spin Hamiltonian, $H = \beta \vec{S}. \overset{\rightleftharpoons}{g}. \vec{H}$ with $S = 1/2$. On the basis of the calculated g values, the measured spin concentrations, and the oxidation–reduction treatments used, five magnetic complexes were attributed to intrinsic defects. Models proposed for these defects are single-charged oxygen vacancies, Ge^{3+}, and O^- or O_2^- ions located in various crystalline symmetries. Hexagonal single crystals of GeO_2 irradiated with electrons exhibited two sets of lines which correlated to two of the complexes in the glasses. A crystal, reactor irradiated at 140°K, displayed an additional set of lines whose properties were described by a spin Hamiltonian, $H = \beta \overset{\rightleftharpoons}{S}. \overset{\rightleftharpoons}{g}. \vec{H} + \vec{S}. \vec{D}. \vec{S}$ with D = 131 ± 2 G, S = 1, g = 1.998 and six equivalent sites related by the crystal symmetry operators. The data were consistent with the hypothesis that this paramagnetic state was due to a doubly charged oxygen vacancy. (auth) (UK)

5199 GAMMA-INDUCED CENTRE IN POTASSIUM BORATE GLASSES. Arafa, S.; Bishay, A. (American Univ., Cairo). Phys. Chem. Glasses; 10: 192-7(5 Oct 1969).

A series of potassium borate glasses containing up to 35 mol % K_2O were irradiated with ^{60}Co, and the induced optical absorption and ESR spectra were studied. An optical absorption band was induced at about 1.9 eV in glasses containing more than 20 mol % K_2O, reaching a maximum intensity at about 33 mol % K_2O. The intensity of this band decreased with the addition of Al_2O_3 which supported the idea that this center is associated with BO_4 units. The observation that this band was not detected in glasses containing less than 20 mol % K_2O suggested, however, that this center is probably associated with BO_4 units in diborate groups. The band decreased in intensity with the addition of Ce^{4+}, thus suggesting that it is due to an electron trap center. The ESR spectra of these glasses showed that in addition to the well-known hyperfine structure resonance, an additional weak line can be detected at about g = 2.00 in glasses containing more than 20 mol % K_2O. This line nearly disappeared after heating at 150°C for one hour, a behavior similar to that of the optical absorption band induced at about 1.9 eV. A comparison with the ESR spectrum of irradiated $Na_2B_4O_7 \cdot 10\,H_2O$ powder confirmed the postulate that this ESR line may be associated with diborate groups in the glass structure. It is postulated that the ESR line at g = 2.00 and the optical absorption band at 1.9 eV correspond to a center consisting of an electron trapped at a non-bridging oxygen ion vacancy in the vicinity of a diborate group. (auth) (UK)

5200 PROCESS OF FORMATION OF DISLOCATION LOOPS IN A BeO CRYSTAL OBSERVED WITH AN ELECTRON MICROSCOPE. Cordier, Alain; Degeilh, Andre (CNRS, Toulouse). Compt. Rend., Ser. B; 269: 355-8(1 Sep 1969). (In French).

The formation of dislocation loops and the volatilization of a BeO crystal in the course of observation with an electron microscope (100 kV) by the effect of secondary emission and the nature of the cleavage faces are explained. (tr-auth)

5201 A STUDY OF THE UV COLOR CENTERS IN NaBr. Jacobs, P. W. M.; Menon, A. Krishna (Univ. of Western Ontario, London). Phys. Status Solidi; 35: K143-5(1 Oct 1969).

A study was made of the uv spectra of color centers produced in very pure and Ca-doped NaBr by x rays. The β band and α band in irradiated pure NaBr are located at 6.31 and 5.76 eV, respectively, and a shoulder is present on the high-energy side of the β band. NaBr : Ca has no α band, but it has the β band and its shoulder, which cannot be the γ band and therefore is called β'. (D.L.C.)

5202 COMPARATIVE STUDY OF OPTICAL ABSORPTION OF SEVERAL SINGLE CRYSTALS OF CALCIUM FLUORIDE IRRADIATED BY X RAYS. Abba, F.; Marqueton, Y.; Decamps, E. A. Phys. Status Solidi; 35: K129-32(1 Oct 1969).

CaF_2 single crystals containing impurities (Y, Al, Sr < 100 ppM; Si, Cu, Fe < 10 ppM) were irradiated with x rays at 20, 40, and 50 kV. From the optical absorption spectra at 1900 to 8500 Å, the crystals fall into two categories: (1) Type I (blue-grey). The spectrum has maxima at 2050, 2300, 3350, 4000, and 5800 Å. The color tends to disappear with time in darkness. The bands all have nearly the same rate of decrease with annealing. (2) Type II (pink). The spectrum has peaks at 2050, 3900, and 5000 Å. In darkness, the crystals retain their pink color. Only the 2050-Å band vanishes with annealing; the 3900- and 5000-Å bands stay constant. The literature is reviewed. The 2500-Å band is ascribed to a Ca interstitial ion or atom. (D.L.C.)

5203 ELECTRON MIRROR MICROSCOPIC OBSERVATIONS OF DRIFT OF LITHIUM IONS ALONG RADIATION DEFECTS IN SILICON. Igras, E.; Przyborski, W.; Warminski, T. (Inst. of Physics, Warsaw). Phys. Status Solidi; 35: K107-10(1 Oct 1969).

The drift of Li ions along regions irradiated with 1-MeV electrons in p-type Si crystals was studied. A p–n junction was created by Li diffusion, and the side diffused with Li was irradiated at 77°K to give 10^{17} to 10^{18} defects/cm^3. The rate of the drift process was found to be faster along irradiated regions; for example, the ion mobility at 80°C is ~3 times faster in regions with 10^{17} radiation defects/cm^3 than in non-bombarded regions. The complex nature of the process is emphasized; in some cases, no drift along irradiated regions can be detected, for a vacancy concentration of 10^{18} cm^{-3}. This is attributed to precipitation of Li on the vacancies. (D.L.C.)

5204 RADIATION DEFECTS CREATED BY ^{60}Co γ RAYS IN p- AND n-TYPE Si OF HIGH PURITY. Konozenko, I. D.; Semenyuk, A. K.; Khivrich, V. I. (Inst. of Physics, Kiev). Phys. Status Solidi; 35: 1043-52(1 Oct 1969).

Radiation defects created by γ irradiation at 300°K in high-purity p-Si ($\rho = 5 \times 10^3$ to 4×10^4 Ω cm) and n-Si ($\rho = 440$ to 5×10^3 Ω cm) were investigated by measurements of Hall effect and minority carrier lifetime. The oxygen concentrations in Si were in the range of 5×10^{14} to 5×10^{15} cm^{-3}; compensation of electrically active impurities was low. It was shown that defects in high-purity Si created at 300°K are divacancies and complexes of vacancies with donor or acceptor impurities. Divacancies introduced by γ-irradiation are not the primary defects. They become predominant after "exhaustion" of the dopant. When divacancies become the predominant defects, the Fermi level occupies its limit position $E_v + 0.390$ eV in the gap. At low doses ($\Phi < 10^{16}$ photons/cm^2) vacancy–impurity complexes and at heavy doses ($\Phi > 10^{17}$ photons/cm^2) divacancies play the main role in the recombination process. (auth)

5205 PROTON SCATTERING FROM SINGLE CRYSTALS. Barrett, Charles S. (Univ. of Chicago). Advan. X-Ray Anal., 12: 72-86(1969).

From 17th Annual Conference on Applications of X-Ray Analysis, Estes Park, Colo. See CONF-680841.

Protons and other energetic particles, when backscattered from a single crystal, emerge with anisotropic intensity distributions. There are minima in the intensities along crystallographic directions and planes. The indices of these directions and planes and the relative intensities of these crystallographic features can be readily established by photographing the pattern of emerging particles. The patterns disclose the symmetry of the scatterer but cannot be expected to reveal the presence or absence of a symmetry center, so that the symmetry of a pattern should be related to the symmetry of one of the 11 Laue-symmetry groups. Photographs made with 50- to 150-keV protons are found to differ not only for crystals that belong to different Laue groups, but also for crystals belonging to the same Laue group but having different space lattices. The patterns reveal a limited amount of structural information including information on orientation, crystal perfection, and axial ratios, but not unit-cell dimensions. The interpretation of patterns on the basis of particle trajectories has had major successes in the past; interpretation on the basis of diffraction has also been proposed but the inherent complexities associated with this are very severe. Some intensity relationships observed for various crystals are presented, and highly simplified approximate ways of predicting relative intensities of lines are compared with the observations. (auth)

5206 TRAPPING AND RE-EMISSION OF FAST DEUTERIUM IONS FROM NICKEL. Erents, K.; McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., D (London), 2: 1397-1406(Oct. 1969).

A simple diffusion model is proposed for the re-emission of fast ions during bombardment of a metal surface. Experiments using a nickel target were conducted in order to make a comparison with this model. Although the experimental results agreed qualitatively with the predicted behavior, the rate of re-emission was much lower than expected on the basis of known diffusion coefficients of deuterium in nickel. Thermal desorption of gas initially trapped in the nickel by bombardment at low temperatures indicated a number of specific activation energies for release, in addition to that associated with diffusion, and these are attributed to radiation damage sites produced during the ion bombardment. (auth) (UK)

5207 ENERGY SPECTRA OF BLOCKING PATTERNS. Anastassiades, A. J.; Filippakis, S. E.; Gangas, N. H.; Sarris, E. T. (Democritus Nuclear Research Centre, Athens). Nucl. Instrum. Methods; 75: 48-50(1969).

The effect of multiple electronic scattering on the angular and energy distribution of protons scattered in the vicinity of a blocking direction in a Si single crystal is investigated experimentally. A fairly good agreement has been found with the theory. (auth)

Physical Properties

Refer also to abstracts 4283 and 4790.

5208 (BNL-14131) SPECTROSCOPIC DETERMINATION OF CRYSTAL FIELD LEVELS OF Pr^{3+} IN THE PARAMAGNETIC METALLIC COMPOUND PrBi. Birgeneau, R. J.; Bucher, E. (Bell Telephone Labs., Murray Hill, N. J.); Passell, L.; Price, D. L.; Turberfield, K. C. (Brookhaven National Lab., Upton, N. Y.). Oct 1969. 12p. (CONF-691103-2). Dep. CFSTI.

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa.

The Pr^{3+} $4f^2$ $^3H_4$ manifold is split by an octahedral crystal field into four levels Γ_1, Γ_3, Γ_4, and Γ_5. Transitions between these levels in PrBi were measured using neutron time-of-flight spectrometry. Peaks in the observed spectra corresponding to crystal field transitions are identified both by their temperature dependence and by comparison with corresponding data from (non-magnetic) LaBi. Well-resolved crystal field transitions are observed at 11.7 and 5.8 ± 0.6 MeV at 90°K. Additional scattering observed at room temperature is consistent with unresolved transitions at 7.6 and 4.1 MeV. As it is known from magnetic measurements that the Γ_1 singlet lies lowest, these four transitions may be identified as Γ_5 to Γ_4, Γ_4 to Γ_1, Γ_5 to Γ_3, and Γ_3 to Γ_4, respectively, thus accounting for all transitions allowed by magnetic dipole selection rules. These data give the parameters $A_4^0\langle r^4\rangle = 6.89 \pm 0.30$ MeV and $A_6^0\langle r^6\rangle = 0.24 \pm 0.10$ MeV. (auth)

5209 PLASMA FREQUENCY OF GRAPHITE. Wei, Chau-chin; Chang, Kun Shu (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan), 7: 24-32(Apr. 1969).

The optical properties and dielectric constant of π-electrons in graphite are discussed. The behavior of the dielectric constant at higher frequency region is calculated and the plasma excitation energy is found to be 6.83 eV. (auth)

5210 FERROMAGNETIC RESONANCE IN $ZrZn_2$. Vallach, E.; Gabbai, A.; Shaltiel, D. (Hebrew Univ., Jerusalem). Phys. Lett.; 30A: 341-2(17 Nov 1969).

The ferromagnetic resonance of the weak itinerant ferromagnet $ZrZn_2$ was measured in the wide frequency range of 0.3 to 36 GHz and at temperatures for 1.4 to 50°K. The results are described and compared to ferromagnetic resonance in d-band metals. The Curie temperature obtained from line width measurements is above 30°K. (auth)

5211 STABILITY OF THE FERROMAGNETIC STATE IN TERBIUM METAL. Jackson, C.; Doniach, S. (Imperial Coll. of Science and Tech., London). Phys. Lett.; 30A: 328-9(17 Nov 1969).

It is suggested that the nature of the ferromagnetic state in Tb metal below 220°K depends in an essential way on the effect of exchange splitting of the conduction bands on the RKKY interaction. (auth)

5212 ESR OF Pb^{3+} IN ThO_2. Roehrig, R. (Institut fuer Elektrowerkstoffe, Freiburg i. B.); Schneider, J. Phys. Lett.; 30A: 371-2(17 Nov 1969).

ESR of Pb^{3+} ions, $6s^1$, is reported for cubic and trigonal sites in ThO_2. A large hyperfine interaction and a negative g shift were observed, the latter in contrast to previous investigations for ZnSe:Pb and ZnTe:Pb. (auth)

5213 SPIN-WAVE CONTRIBUTIONS TO THE RESISTIVITY OF DYSPROSIUM THIN FILMS. Lodge, F. M. K.; Taylor, K. N. R. (Physics Dept., Durham City, Eng.). Phys. Lett.; 30A: 359-60(17 Nov 1969).

The spin resistivity of dysprosium thin films was determined from 4.2 to 300°K. The results show that below 60°K the resistance is governed by spin-wave scattering with a spin-wave activation energy of about 24°K. Above 60°K, the spin resistivity is proportional to $T^{\frac{3}{2}}$ and it is shown that this is consistent with the behavior of other related phenomena in bulk samples. (auth)

5214 OBSERVATIONS OF THE FIELD-EVAPORATION END FORM OF TUNGSTEN. Loberg, B.; Norden, H. (Chalmers Tekniska Hogskola, Goteborg). Ark. Fys.; 39: 383-95 (1969).

The field-evaporation end form of tungsten was studied by electron microscopy. The results were compared with observations obtained by field-ion microscopy. The effect of close-packed planes on the end form is considered. The influence of shank angle and specimen orientation on the specimen shape is discussed. (SWEDEN)

5215 THE INFLUENCE OF TEMPERATURE ON THE DEFORMATION MECHANISM OF MOLYBDENUM SINGLE CRYSTALS. Richter, J. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Phys. Status Solidi; 35: K119-21(1 Oct 1969).

A study was made of the stress–strain characteristics and the slip geometry of Mo single crystals deformed in tension at 293 to 573°K at strain rates of $\sim 10^{-5}$ sec^{-1}. The stress–strain curves of middle oriented crystals are parabolic at 293 to 370°K and exhibited three-stage hardening above 400°K. From the slip line patterns, all four slip directions of type $\langle 111\rangle$ operate at room temperature after weak extension; at higher strains, the $[11\bar{1}]$ and [111] directions are preferred. At 320 to 370°K, $[11\bar{1}]$ and [111] are the main slip directions, but above 400°K, only the stress-favored $[11\bar{1}]$ slip direction operates. In stage II, $[1\bar{1}1]$ also became active. The main slip plane is the maximum resolved shear stress plane (101). For crystals of other orientations deformed at 493°K, only the $[11\bar{1}]$ slip direction is operative, giving rise to the three-stage hardening. (D.L.C.)

5216 ELECTRICAL PROPERTIES OF MONOCRYSTALLINE URANIUM DIPHOSPHIDE. Henkie, Z.; Trzebiatowski, W. (Inst. of Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi; 35: 827-34(1 Oct 1969).

Electric resistivity (2 to 600°K), thermoelectric power (100 to 700°K), and Hall effect (290 to 450°K) were determined for single crystals and polycrystalline samples of UP_2. This compound possesses tetragonal structure and exhibits a strong anisotropy of the transport properties. At room temperature, the resistivity along the c-axis is about three times larger than in the perpendicular direction (≈700 and 205 μΩ cm, respectively), while the thermoelectric power is two times lower along the c-axis (≈ +20 and +37.8 μV/°K). The ordinary Hall coefficient with negative sign is equal to -3×10^{-12} V-cm/A-Oe, the carrier concentration is 2×10^{22} cm^{-3}, and the estimated Fermi energy is about 3.2 eV. The phenomenological interpretation of the obtained data is based on a model with a conduction band resulting from the overlap of 7s and 6d bands while the 5f electrons yield a narrow band of lower energy lying apart from the conduction band. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 4478 and 4480.

5217 NOTES ON THE LOCALIZED MOMENT OF Fe IMPURITY IN Nb-Mo ALLOYS. Nagasawa, Hiroshi; Sakai, Nobuhiko (Tokyo Univ.). J. Phys. Soc. Jap., 27: 1150-2(Nov. 1969).

By Moessbauer measurement of enriched ^{57}Fe in Nb_3Mo_7 alloys at high field at 4.2°K and 120°K, the existence of the nonmagnetic Fe impurity in Nb–Mo alloys was observed, and from the composition dependence of the effective moment of Fe impurity, it was found that the Fe impurity has a localized moment when it has at least seven Mo nearest neighbors. (auth)

5218 YADERNYI MAGNITNYI REZONANS V FERRO- I ANTIFERRO-MAGNETIKAKH. (Nuclear Magnetic Resonance in Ferro- and Antiferro-Magnetics). Turov, E. A.; Petrov, M. P. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1969. 260p.

Data are compiled on physical concepts of basic nuclear magnetic resonance (NMR) phenomena in ferromagnetics and antiferromagnetics. The first chapter covers the properties of nuclear magnetic resonance. Resonance frequencies, radiofrequency susceptibility and amplification coefficients are discussed in the second and third chapters. Indirect interactions between nuclear spins, nuclear spin waves, relaxation processes, widths of NMR lines, and quadrupole effects are included in the fourth, fifth, and sixth chapters. The seventh, eighth, and nineth chapters cover the properties of NMR in the domain boundaries, the chemical bond and NMR of nonmagnetic ions, and nuclear magnetic-acoustic resonance. The tenth and last chapter deals with the properties of NMR apparatuses for magnetic crystals. A table of NMR experimental data for individual nuclei (^{1}H through ^{169}Tm) in ferro- and antiferromagnetics (resonance frequencies and local fields) are included in the supplement. 339 references. (R.V.J.)

5219 CALCULATION OF THE KNIGHT SHIFT IN BERYLLIUM. Gerstner, J.; Cutler, P. H. (Pennsylvania State Univ., University Park). Phys. Lett.; 30A: 368-9(17 Nov 1969).

A nonlocal pseudopotential theory was used to calculate the contributions to the Knight shift in beryllium. For the first time, the computed value has both the correct sign and numerical agreement with recent experiments. (auth)

5220 TABLITSY CHASTOT YADERNOGO KVADRUPOL'-NOGO REZONANSA. (Nuclear Quadrupole Resonance Frequency Tables). Biryukov, I. P.; Voronkov, M. G.; Safin, I. A. Leningrad, Izdatel'stvo Khimiya Leningradskoe Otdelenie, 1968. 140p.

Detailed information is given on nuclear quadrupole resonance for 1200 individual chemical substances. The book offers important data in resolving some chemical and physical problems of solids. Brief tables are first given of characteristics of stable nuclear isotopes with I ≥ 1 spin, and transition frequencies between quadrupole energy levels, after which extensive tables of NQR frequencies for the various compounds are presented. 338 references. (R.V.J.)

Theory

5221 SPIN WAVES. Akhiezer, A. I.; Bar'yakhtar, V. G.; Peletminskii, S. V. North-Holland Series in Low Temperature Physics. Volume 1. New York, John Wiley and Sons, Inc., 1968. 376p. $21.50.
Translated by S. Chomet.

Spin waves, treated in this book, are one class of properties (excitations near the ground state) resulting from the Heisenberg model of ferro- and antiferromagnetic systems. The eight chapters cover macroscopic theory, high-frequency properties, coupled magnetoelastic waves, quantum theory, thermodynamics, kinetic effects, and quantum theory using indefinite metric. (D.L.C.)

Theoretical Physics

Refer also to abstract 5336.

5222 (IS-1795) WAVE PACKET SOLUTIONS OF THE TIME DEPENDENT SCHROEDINGER EQUATION. Weber, T. A.; Hammer, C. L. (Ames Lab., Iowa). Mar. 26, 1968. 27p. Dep. CFSTI.

The wave-packet solutions of the nonrelativistic time-dependent Schroedinger equation are considered for cases where the usual scattering approximations have doubtful or no validity. The results, although very similar in form to the results of the usual Lippmann–Schwinger formalism, are exact, rather than approximate, even when the incident wave packet is a finite distance from the scattering center. Consequently, solutions that involve time dependence, such as decaying states, are included in the formalism. The formalism is first developed for the one-dimensional case and then generalized to three dimensions. (auth)

5223 ENERGY LOSSES OF A RELATIVISTIC PARTICLE PASSING THROUGH A PLATE OF ARBITRARY THICKNESS. Garibyan, G. M.; Muradyan, M. M. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1326-32(1969). (In Russian).

A perpendicular transit of a relativistic charged particle through a plate is considered. A mathematical method is given to estimate the electromagnetic energy losses of the particle in the plate, which allows use of the integration method of Landau in these calculations. A general formula obtained gives the energy losses in the plate of arbitrary thickness, which in the limiting cases of small and large thicknesses of the plate, are transformed into known expressions. (auth)

5224 FINE STRUCTURE OF THE SPECTRUM OF SYNCHROTRON RADIATION. Gertsenshtein, M. E.; Malakhov, A. N.; Bokun, R. Ch. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1401-10 (1969). (In Russian).

The fine structure of the spectrum of synchrotron radiation from a beam of relativistic electrons is calculated, taking synchrotron oscillations into account. The formulas are derived for the line and pedestal intensity. It is shown that, at the higher harmonics, the line is exponentially small and the pedestal has some narrow pitches that permits, in principle, a comparison of the infrared and radio frequencies within an accuracy of 10^{-12}. (auth)

5225 INFORMATION CONTENT IN QUANTUM-MECHANICAL SYSTEMS. Majernik, V. (Inst. of Physics, Bratislava). Nuovo Cim.; 64A: 501-6(1 Dec 1969).

The determination of information contained in a quantum-mechanical system about another one is studied. The following couples of systems are considered: i) two different quantum-mechanical systems with a physical interaction, ii) a quantum-mechanical system at time t_1 and the same system at time t_2. In the first case a scalar measure for the magnitude of physical interaction between two quantum-mechanical systems is proposed. In the second case a factor for indeterminism of time development of a quantum-mechanical system is proposed, too. (auth)

5226 NOTE ON HALF-SPACE PROBLEMS IN THE RESTRICTED TWO-GROUP TRANSPORT THEORY. Thielheim, K. O.; Bloecker, W. (Univ., Kiel). Z. Phys.; 230: 95-8(1970).

Explicit solutions are presented for half space problems in the restricted two-group transport theory. (auth)

5227 EPISTEMOLOGY OF QUANTUM MECHANICS. Wigner, E. P. (Univ. of Princeton, N. J.). pp 431-7 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The general consequences of quantum mechanics are discussed and the open questions are outlined. (auth)

5228 HIDDEN VARIABLE THEORIES AS A STEP TOWARDS A NEW LANGUAGE STRUCTURE FOR PHYSICS. Bohm, D. (London Univ.). pp 439-48 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The need for considering new language structures in an attempt to penetrate new domains is stressed. (auth)

5229 THE CONTINUITY PROBLEM: A WAY OUT. Bastin, Ted (Cambridge Language Research Unit, Eng.). pp 451-8 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

A case is presented for regarding quantum theory as a theory of limited applicability, and an attempt is made to estimate its success in its proper field of application seeing it from outside. It is concluded that quantum theory does not provide an explanation of atomicity (or discreteness). This failure is attributed to the appeal inherent in all current forms of quantum theory to ideas of continuum physics which—unless they can be otherwise formulated—are incompatible with the assumption of discreteness. The Bohr philosophy is seen to be a way of working in the presence of this incompatibility, but not a solution of it. A theory is described in general terms in which the continua of space and time are constructed by progressive interpolation of points, starting with algebraic structures which incorporate the scale constants (dimensionless constants) of physics. Besides showing that it is possible to solve the discrete/continuous incompatibility, this approach assigns to the observing system the necessary place in physical theory that quantum theory claims for it. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

5230 ANALYSIS OF SOME RESULTS OF QUARK SEARCHES. Adair, R. K. (Yale Univ., New Haven); Kasha, H. Phys. Rev. Lett.; 23: 1355-8(8 Dec 1969).

The interpretation of the results of Cairns, McCusker, Peak, and Woolcott, indicating a discovery of quarks in the cores of very energetic extensive air showers, is shown to be extremely difficult to reconcile with the results of other negative experiments. Alternative explanations of their results are then suggested. (auth)

Electromagnetic

Refer also to abstract 5331.

5231 (NP-18072) ON PION ELECTROPRODUCTION AT 5 F^{-2} NEAR THRESHOLD. Note No. 229. Amaldi, E.; Balla, M.; Borgia, B.; Di Giorgio, G. V.; Giazotto, A.; Pistilli, P.; Serbassi, S.; Stoppini, G. (Rome Univ. (Italy). Istituto di Fisica). 8 Jul 1969. 40p. Dep. CFSTI (U. S. Sales Only).

A coincidence experiment designed for determining the electroproduction cross section at threshold is described. At a four-momentum transfer $k^2 = 0.2$ $(GeV/c)^2$ and a polarization of the exchanged virtual photon $\epsilon = 0.74$, one finds for π^+: $\lim_{q^* \to 0} (d\sigma/d\omega_{eL}\, dr_{oe})_{\pi^+} = 4.9 \times 10^{-31}$ cm^2/[str × (GeV)^2/c] ± 14%, where q^* is the trimomentum of the pion in the frame of the cm of the (pion + nucleon) system observed in the final state. This value of the cross section agrees within 10% with the theoretical value obtained in Born approximation. By using a formula derived by De Tollis and Nicolò the following limits for the π^+ electromagnetic form factor are deduced from the cross section at threshold given above: $0.76 \leq F_\pi \leq 1$. The same data were analyzed in terms of a formula deduced by Gleeson, et al. by means of current algebra techniques and PCAC assumption, which allows a determination of the mass appearing in the nucleon axial-vector form factor. From the present measurements one obtains: $M_A = (1.03 \pm 0.07)$ GeV, in good agreement with the usually accepted value. From the measurements of the π^0 electroproduction only a very low upper limit of the cross section at threshold can be derived. The cross section, however, increases rapidly with q^* reaching a value equal to about 30% of the π^+ cross section already at q^* around 50 MeV/c. (auth)

5232 PHOTOPRODUCTION OF THE A_2 MESON IN THE REACTION $\gamma p \to n\pi^+\pi^+\pi^-$ AND AN ESTIMATE OF THE $A_2\,\gamma\pi$ WIDTH. Eisenberg, Y. (Weizmann Inst. of Science, Rehovoth, Israel); Haber, B.; Horovitz, B.; (and others). Phys. Rev. Lett.; 23: 1322-4(1 Dec 1969).

The production of the A_2 meson was observed in the reaction $\gamma p \to n\pi^+\pi^+\pi^-$ at 4.3 and 5.25 GeV. The data are consistent with a one-pion-exchange production mechanism. An estimate is given of $\Gamma(A_2 \to \gamma\pi) \approx 0.5$ MeV. A similar value for $\Gamma(A_2 \to \gamma\pi)$ is also obtained using a vector dominance model. (auth)

5233 ELECTRONS AND PHOTONS AT HIGH ENERGIES. Braben, Donald W. (Darebury Nuclear Physics Lab., Eng.). New Sci.; 44: 348-50(13 Nov 1969).

The theme of this paper is that the relatively new field of high-energy electron and photon physics may supply the missing clues needed to unify theories of elementary particles. (auth)

5234 SINGLE-$\pi^\pm$ AND -K^+ PHOTOPRODUCTION FROM COMPLEX NUCLEI AT 8 AND 16 GeV. Boyarski, A. M.; Diebold, R.; Ecklund, S. D.; Fischer, G. E.; Murata, Y.; Richter, B.; Sands, M. (Stanford Univ., Calif.). Phys. Rev. Lett.; 23: 1343-6 (8 Dec. 1969).

The reactions $\gamma A \to \pi^\pm A^*$ were studied at four-momentum transfers $-t \leq 0.5$ GeV^2 for seven elements ranging from hydrogen to lead. Exclusion-principal suppression is clearly visible at small-momentum transfer. Neither the A dependence nor the energy dependence of the cross sections agrees with the predictions of the vector-dominance model. The ratio of π^-/π^+ production requires equal spatial distributions for the protons and neutrons in nuclei. Some K^+ data are also presented. (auth)

Weak

Refer also to abstract 5017.

5235 STUDY OF THE π^- MESONIC DECAY OF THE Λ He^5 HYPERNUCLEUS. Gajewski, W. (Univ., Warsaw); Naisse, J.; Sacton, J.; Vilain, P.; Wilquet, G. Nucl. Phys.; B14: 11-27(1969).

Some 2780 (π^- ^1H ^4He) and 15 (π^- ^2H ^3He) decays of the Λ He^5 hypernucleus were collected and analyzed. The energy spectra and the angular distribution of the decay products were studied. An improved formulation of the theoretical model describing the (π^- ^1H ^4He) decay was made, allowing a detailed comparison between theory and experiment. (auth)

5236 DETERMINATION OF THE K_s DECAY BRANCHING RATIO. Bozoki, G.; Fenyves, E.; Gombosi, E.; Nagy, E.; Suranyi, G.; Telbisz, F.; Vesztergombi, G. (Central Research Inst. of Physics, Budapest). Phys. Lett.; 30B: 498-9(24 Nov 1969).

The measurement is carried out by means of the Ecole Polytechnique 1 m heavy liquid bubble chamber irradiated by 8000 MeV/c K^+ beam. The charged-to-neutral branching ratio turned out to be 2.12 ± 0.17. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 5258 and 5284.

5237 (PPAR-11) PROTON-PROTON DIFFERENTIAL CROSS SECTION FROM 600 TO 1800 MeV/c. Ryan, B. A.; Kanofsky, A.; Devlin, T. J.; Mischke, R. E.; Shepard, P. F. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar 1969. Contract AT(30-1)-2137. 100p. Dep. CFSTI.

Proton-proton elastic differential cross sections were measured in the 34° beam line of the 3-GeV Princeton-Pennsylvania Accelerator for incident lab momenta of 600 to 1800 MeV/c and center-of-mass angles of 5 to 90°. The momenta of the protons incident on a liquid-hydrogen target were measured by time-of-flight techniques. The momenta and scattering angles of the recoil protons were measured by a spectrometer consisting of two sets of magnetostrictive wire spark chambers placed at the entrance and exit of an analyzing magnet. A kinematical reconstruction was performed for each event by an on-line PDP-7 computer which also recorded the raw data and monitored various aspects of the experimental equipment. A more detailed off-line analysis resulted in normalized differential cross sections. The differential cross sections were compared with simple models for p-p scattering which proved to be inadequate to explain many of the experimental details. (auth)

5238 LARGE-ANGLE ELASTIC PROTON-PROTON SCATTERING FROM 1.5 TO 3.5 GeV/c. Brabson, B. B.; Crittenden, R. R.; Heinz, R. M.; Kammerud, R. C.; Neal, H. A.; Paik, H. W.; Sidwell, R. A.; Suen, K. F. (Indiana Univ., Bloomington). Phys. Rev. Lett.; 23: 1306-10(1 Dec 1969).

The p-p elastic differential cross-section results are presented for nine momenta in the range 1.5 to 3.5 GeV/c for $40° \lesssim \theta_{cm} \leq 90°$. No strong evidence of secondary diffraction-like behavior in this momentum region is observed. Rapid changes in the slope of the 90° cross section are seen near $-t = 0.7$ and 3 $(GeV/c)^2$. (auth)

5239 HADRON-NUCLEON TOTAL CROSS SECTIONS AT HIGH ENERGIES. Galbraith, W. (Univ. of Sheffield, Eng.). Rep. Progr. Phys.; 32: 547-606(Oct 1969).

During the last decade considerable progress has been made both experimentally, in determining to high precision the hadron-nucleon total cross sections, and theoretically, in accounting for the magnitude and behavior of these cross sections as a function of energy. The work was chiefly concerned with those hadrons (pions, kaons, nucleons) normally obtained in particle beams at proton synchrotrons, and the basis of the experimental method, involving electronic counter techniques, is discussed in detail. The experimental data have given a wealth of information on the energy dependence of the hadron-nucleon interactions. A discussion of some of the pertinent theoretical aspects is included. (auth)

5240 SOME TOPICS ON MESON RESONANCES. Montanet, L. (CERN, Geneva). pp 379-413 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967.

See CONF-671087.

Some topics are reviewed which were investigated in meson annihilations of proton-antiprotons at low energies. For this purpose the nonrelativistic quark model is used. The X^0 puzzle and the I = $K\bar{K}$ structure at threshold, the meson (E), and the mesons (D) and (B), and the K* (1250) – K* (1320) puzzle are discussed. (J.F.P.)

5241 ANALYSIS OF THE I = 0 ($K\bar{K}\pi$) RESONANCES PRODUCED IN $\bar{p}p$ ANNIHILATIONS AT 0.7 GeV/c: THE D, E, AND f′ MESONS. Loerstad, B. (College de France, Paris); d'Andlau, Ch.; Astier, A.; Cohen-Ganouna, J.; Della-Negra, M.; Aguilar-Benitez, M.; Barlow, J.; Jacobs, L. D.; Malecki, P.; Montanet, L. Nucl. Phys.; B14: 63–74(1969).

The D, E and f′ mesons are observed in $\bar{p}p$ annihilations at 0.7 GeV/c. The quantum numbers of the D and E are analyzed. A limit is given for the $f' \to K^*K/K_1^0K_1^0$ branching ratio. (auth)

5242 TWO-BODY HYPERON PRODUCTION BY 5.7 GeV/c ANTIPROTONS ON PROTONS. Atherton, H. W.; Celnikier, L. M.; French, B.; Kinson, J. B.; Myklebost, K.; Pernegr, J.; Quercigh, E.; Sadoulet, B. (CERN, Geneva). Phys. Lett.; 30B: 494–7(24 Nov 1969).

Total and differential cross sections are presented on the reactions: $\bar{p}p \to \bar{\Lambda}\Lambda$, $\bar{\Lambda}\Sigma^0$ + c.c., $\overline{\Sigma^+}\Sigma^+$ at an incident momentum of 5.7 GeV/c, from 200,000 photographs (13 events/μ b) of the CERN 2 meter hydrogen bubble chamber. The "forbidden" reaction $\bar{p}p \to \overline{\Sigma^-}\Sigma^-$ is also observed and its cross section is 1.3 ± 0.4 μb. Polarization and correlation of polarizations are presented for the reaction $\bar{p}p \to \bar{\Lambda}\Lambda$. (auth)

5243 FURTHER MEASUREMENTS ON THE PRODUCTION OF π^- AND K^- MESONS AND ANTIPROTONS AT THE 70 GeV IHEP ACCELERATOR. Binon, F. (CERN, Geneva); Denisov, S. P.; Duteil, P.; (and others). Phys. Lett.; 30B: 506–9(24 Nov 1969).

Measurements on the production of intermediate momenta negative pions, negative kaons, and antiprotons by protons of 43 GeV, 52 GeV, and 70 GeV on aluminum nuclei are reported. (auth)

5244 PRODUCTION OF ANTIDEUTERONS BY 43 GeV, 52 GeV, AND 70 GeV PROTONS. Binon, F. (CERN, Geneva); Duteil, P.; Kachanov, V. A.; (and others). Phys. Lett.; 30B: 510–13(24 Nov 1969).

The production of antideuterons on aluminum nuclei by 43 GeV, 52 GeV, and 70 GeV protons was measured. (auth)

5245 EXPERIMENTAL RESULTS ON THE $\omega\pi$ AND $\pi\pi$ SYSTEMS AS OBSERVED IN THE $\bar{p}p$ ANNIHILATIONS AT REST: $\bar{p}p \to \omega^0\pi^+\pi^-$. Bizzarri, R. (CERN, Geneva); Foster, M.; Gavillet, Ph.; Labrosse, G.; Montanet, L.; Salmeron, R.; Villemoes, P.; Ghesquiere, C.; Lillestoel, E. Nucl. Phys.; B14: 169–94(1969).

2400 events of the type $\bar{p}p \to \omega^0\pi^+\pi^-$ are extracted from more than 10,000 five-body annihilations at rest: $\bar{p}p \to 2\pi^+2\pi^-\pi^0$. The B meson is observed in the system ($\omega\pi$): its mass, width, and spin-parity are analyzed. Limits are given for the branching ratios $B \to \Phi\pi/B \to \omega\pi$ and $B \to K\bar{K}/B \to \omega\pi$. It is necessary to introduce a structure in the ($\pi\pi$) S-wave, I = 0 amplitude to obtain a good interpretation of the data. (auth)

5246 AN ANALYSIS OF THE REACTION $\bar{p}p \to K^0\bar{K}^0\pi^+\pi^-$ AT 0.7 GeV/c AND THE SPIN–PARITY OF THE F_1 MESON. Aguilar-Benitez, M. (CERN, Geneva); Barlow, J.; Jacobs, L. D.; Malecki, P.; Montanet, L.; d'Andlau, Ch.; Astier, A.; Cohen-Ganouna, J.; Della Negra, M.; Loerstad, B. Nucl. Phys.; B14: 195–207(1969).

Experimental results are presented on the reactions $\bar{p}p \to K_1^0K_1^0\pi^+\pi^-$ and $\bar{p}p \to K_1^0K_2^0\pi^+\pi^-$ at 0.7 GeV/c. The production of K*, S*, f^0, φ, ρ is observed, as well as the recently proposed F_1 meson: its spin–parity quantum numbers are discussed. (auth)

Strong (Meson-Induced)

Refer also to abstract 5284.

5247 (CERN-HERA–69-1) COMPILATION OF PION–NUCLEON SCATTERING DATA. Giacomelli, G.; Pini, P.; Stagni, S. (European Organization for Nuclear Research, Geneva (Switzerland)). 7 Nov 1969. 114p. Dep. CFSTI (U. S. Sales Only).

A computerized compilation of 9574 existing data on pion-nucleon scattering is presented. (auth)

5248 A STUDY OF MUONS DEEP UNDERGROUND. II. THE RATE OF ENERGY LOSS. Barton, J. C.; Stockel, C. T. (Northern Polytechnic, London). J. Phys., A (London); 2: 650–7(Nov 1969).

The usual method of determining the rate of energy loss of muons by comparison of the sea-level spectrum with the intensity underground is shown to be inadequate to determine the energy-dependent term because of the imprecision of the spectrograph results. An alternative method was developed in which the rate of energy loss is deduced from the observed mean pulse height of a scintillation counter operated underground. This method requires a knowledge of the intensity–depth curve but not of the muon momentum spectrum. The various corrections necessary to apply the method to the results of the experiment described in J. Phys. A 2: 639–49(Nov. 1969), are considered and shown to be small. The energy loss by direct pair production is found to be 1.05 ± 0.20 times the value predicted by Kobayakawa (1967 and 1968). (auth)

5249 MESON RESONANCES. Lanius, Karl (Inst. of High-Energy Physics, Berlin). pp 255–323 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Experiments planned for the 70 GeV proton accelerator are briefly reviewed. The experiments and data obtained with the bubble chambers, an analysis of A-mesons and complications encountered during studies of heavy boson resonances, and a brief review of up to date data on meson resonance are covered. (R.V.J.)

5250 STUDY OF THE EXCHANGE MECHANISM IN $K^+p \to K^+\pi^-N^{*++}$ AT 5 GeV/c INCOMING K^+ MOMENTUM. Bassompierre, G. (CERN, Geneva); Eskreys, A.; Goldschmidt-Clermont, Y.; (and others). Nucl. Phys.; B14: 143–52(1969).

Results are presented on the analysis of the quasi three-body reaction $K^+p \to K^+\pi^-N^{*2+}$ obtained from bubble chamber exposures at 5 GeV/c incident K^+ momentum. A method of analysis based on the study of the longitudinal phase space plot recently proposed by Van Hove was applied. Evidence for the existence of π^- mesons with a four-momentum transfer peaked at small values is shown. (Events contributing to this peak correspond to the cross section of about 80 μb.) The difficulties in explaining this result in terms of the double-particle exchange model are discussed. (auth)

5251 MEASUREMENT OF THE LIFETIMES OF THE $\Sigma^\pm$ HYPERONS AND OF THE BRANCHING RATIO OF THE NON-LEPTONIC Σ^+ DECAY. Barloutaud, R. (CEN, Saclay, France); De Bellefon, A.; Granet, P.; (and others). Nucl. Phys.; B14: 153–60(1969).

The measurements were done using about 20,000 reactions $K^-p \to \Sigma^\pm\pi^\mp$ with K^- momenta from 400 to 1200 MeV/c and give $\tau^+ = (0.803 \pm 0.008)\cdot 10^{-10}$ sec. $\tau^- = (1.472 \pm 0.016)\cdot 10^{-10}$ sec and $R = (\Sigma^+ \to n\pi^+)/[(\Sigma^+ \to n\pi^+) + (\Sigma^+ \to p\pi^0)] = 0.488 \pm 0.010$. The result for τ^- is in serious disagreement with the generally accepted value. (auth)

5252 K^+p ELASTIC SCATTERING IN THE INTERMEDIATE MOMENTUM RANGE REGION (2.1 TO 2.7 GeV/c). Danysz, J. A. (CEN, Saclay, France); Spiro, M.; Verglas, A.; Brunet, J. M.; Narjoux, J. L.; Penney, B.; Thompson, G.; Lewis, P. H.; Allen, J. E.; March, P. V. Nucl. Phys.; B14: 161–8(1969).

Preliminary results on total and differential K^+p elastic cross sections are presented at 2.11, 2.31, 2.53, 2.72 GeV/c incident K^+ momenta. A Legendre polynomial analysis of the s-channel does not require more than a G-wave. On the other hand, a good description is obtained by extrapolating t-channel Regge pole calculations to these low energies. A reasonable agreement is found down to $t = -0.7\ (\text{GeV}/c)^2$. (auth)

5253 STUDY OF THE REACTION $K^+p \to K^0\pi^+p$ AT 9 GeV/c. Lind, V. Gordon; Alexander, G.; Firestone, A.; Fu, C.; Goldhaber, G. (Univ. of California, Berkeley). Nucl. Phys.; B14: 1–10(1969).

Results are presented on the study of the reaction $K^+p \to K^0\pi^+p$ at 9 GeV/c. The reaction proceeds almost entirely through the production of K^*_{890}, K^*_{1420}, and Δ^{++}_{1236}. The spin parity of the K^*_{1420} is shown to be $J^P = 2^+$, with 18% pseudoscalar and 72% vector exchange in its production, the same proportion as for K^*_{890} production. The dependence of the cross sections on incident momentum for the reactions $K^+p \to K^*_{890}p$, $K^*_{1420}p$, and $K^0\Delta^{++}_{1236}$ appear to fall somewhat more rapidly than the predictions of a simple Regge-pole-exchange model. (auth)

5254 STUDY OF THE REACTION $K^-n \to \Lambda\pi^-$ AT 3.9 AND 3.6 GeV/c: TEST OF EXCHANGE DEGENERACY IN THE t REGION AND AN OBSERVATION OF A BACKWARD PEAK IN THE u REGION. Crennell, David J. (Brookhaven National Lab., Upton, N. Y.); Karshon, Uri; Lai, Kwan Wu; O'Neall, John S.; Scarr, J. Michael; Lea, Robert M.; Schumann, Thomas G.; Urvater, Ernest M. Phys. Rev. Lett.; 23: 1347–50(8 Dec 1969).

Angular distributions in the low-|t| region in the reaction $K^-n \rightarrow \Lambda\pi^-$ and in the line-reversed reaction $\pi^-p \rightarrow \Lambda K^0$ and from other complementary experiments do not support the predictions of exchange degeneracy between the $K_{\frac{1}{2}}{}^*(890)$ and the $K_{\frac{1}{2}}{}^*(1420)$ up to $s \sim 11$ GeV^2. In the low-|u| region of the reaction $K^-n \rightarrow \Lambda\pi^-$ at 3.9 GeV/c, a peak is observed with a slope of 10 ± 3 GeV^{-2} followed by a valley from u = −0.15 to −0.4 GeV^2. A simple Regge-pole fit to this backward-scattering region using the N_α trajectory is presented. (auth)

5255 NEW EXPERIMENTAL RESULTS ON THE REACTIONS $K^-p \rightarrow \bar{K}N$ AND $K^-p \rightarrow \Sigma\pi$ AND A PARTIAL-WAVE ANALYSIS BETWEEN 430 AND 800 MeV/c. Armenteros, R. (CERN, Geneva); Baillon, P.; Bricman, C.; (and others). Nucl. Phys.; B14: 91-105 (1969).

The reactions $K^-p \rightarrow K^-p$, $\bar{K}^0n$ and $K^-p \rightarrow \Sigma^+\pi^-$, $\Sigma^0\pi^0$, $\Sigma^-\pi^+$ were studied in the cm energy range 1530 to 1700 MeV; new experimental data are presented and results of an energy-dependent partial-wave analysis are discussed. (auth)

5256 THE $\bar{K}N$ INTERACTION FROM 800 to 1200 MeV/c. III. A STUDY OF Λ(1520). Burkhardt, E. (Univ., Heidelberg); Filthuth, H ; Kluge, E.; (and others). Nucl. Phys.; B14: 106-18 (1969).

The resonant parameters of Λ(1520) were determined from an analysis of the reaction sequence $K^-p \rightarrow \Sigma(1760) \rightarrow \Lambda(1520)\pi^0$ with subsequent decay of Λ(1520) into K^-p, $\Sigma^\pm\pi^\mp$ and $\Lambda\pi^+\pi^-$. The best values for the Λ(1520) mass and width are: $E_R = 1517.2 \pm 0.6$ MeV. $\Gamma = 14.7 \pm 1.8$ MeV. Its decay branching ratios are $\Gamma(\Sigma\pi)/\Gamma(\bar{K}N)$ 0.82 ± 0.08 and $\Gamma(\Lambda\pi\pi)/\Gamma(\bar{K}N) = 0.22 \pm 0.03$ and its branching fractions $\Gamma(\bar{K}N)/\Gamma = 0.49 \pm 0.02$. $\Gamma(\Sigma\pi)/\Gamma = 0.40 \pm 0.02$. $\Gamma(\Lambda\pi\pi)/\Gamma = 0.11 \pm 0.01$. (auth)

5257 $\omega\rho^0$ INTERFERENCE EFFECT IN THE $\pi^+p \rightarrow \pi^+\pi^-\Delta^{++}$ INTERACTION. Goldhaber, G.; Butler, W. R.; Coyne, D. G.; Hall, B. H.; MacNaughton, J. N.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev. Lett.; 23: 1351-4(8 Dec 1969).

Evidence for a destructive interference effect between the ρ^0 and $\omega \rightarrow \pi^+\pi^-$ amplitudes has been observed in the channel $\pi^+p \rightarrow \pi^+\pi^-\Delta^{2+}$ at 3.7 to 4.0 GeV/c. On the assumption of complete coherence between the ρ^0 and $\omega \rightarrow \pi^+\pi^-$ amplitude in a subsample, discussed in the text, a branching ratio $(\omega \rightarrow \pi^+\pi^-)/(\omega \rightarrow \pi^+\pi^-\pi^0) =$ 1.5% is obtained with a 95% confidence-level lower limit of 0.25%. The data do not lead to a significant upper limit. In terms of δ, the off-diagonal element of the $\rho^0\omega$ mass-mixing matrix, these values are equivalent to $\delta = 2.7$ MeV and a lower limit of 1.1 MeV. Under conditions stated in the text, a value $\beta = 1.5 \pm 0.3$ RAD is obtained for the production phase of ρ^0 relative to ω in the channel studied. (auth)

5258 TOTAL CROSS SECTIONS OF π^-, K^-, AND $\bar{p}$ ON PROTONS AND DEUTERONS IN THE MOMENTUM RANGE 20 TO 65 GeV/c. Allaby, J. V. (CERN, Geneva); Bushnin, Yu. B.; Denisov, S. P.; (and others). Phys. Lett.; 30B: 500-5(24 Nov 1969).

Total cross-section data are presented for negative pions, kaons, and antiprotons on protons and deuterons in the momentum range 20 GeV/c to 65 GeV/c in 5 GeV/c steps. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 5346.

5259 (NYO-2262-TA-166(Rev.)) ELEMENTARY AND COMPOSITE PARTICLES IN FIELD THEORY AND S-MATRIX THEORY. Kang, Kyungsik (Brown Univ., Providence, R. I. Dept. of Physics); Land, David J. (Naval Ordnance Lab., White Oak, Md.). [1968]. 44p. Dep. CFSTI.

The definition of a particle as elementary or composite and the decomposition of the scattering amplitude into one-particle reducible and irreducible parts for both types of particles are reexamined. For the composite-particle solution the decomposition is based on identifying the field-theoretic quantities for the composite particle with the corresponding quantities for the elementary particle. The cancellation mechanism between the poles of the proper vertex function and the zeros of the propagator is then proven when the propagator satisfies a once subtracted Källen–Lehmann representation, so that vertex poles do not lead to poles in the scattering amplitude. The dynamical origin of vertex poles is discussed. The compositeness conditions used previously and show how these conditions follow from the construction of the various field-theoretic and S-matrix quantities. However, it is found that the popular compositeness conditions $Z_3 = 0$, $Z_1 = 0$ are not sufficient to obtain the composite particle in field theory without a restriction on the propagator. The asymptotic behavior of both field-theoretic and S-matrix quantities is discussed briefly. (auth)

5260 (STI/PUB–214(Vol.2)) CONTEMPORARY PHYSICS: TRIESTE SYMPOSIUM 1968. VOL. II. Proceedings of the International Symposium, Trieste, June 7–28, 1968. (International Atomic Energy Agency, Vienna (Austria)). 1969. 507p. (CONF-680629–(Vol.2)). IAEA $11.00.

Separate abstracts were prepared for the 34 papers included. (J.W.R.)

For abstracts of individual papers see: 5227–5229, 5261–5263, 5285, 5286, 5308, 5309, 5321, 5323, 5325–5327, 5333–5338, 5348–5351, and 5452–5460.

5261 CURRENT ALGEBRA. Fubini, S. (Univ. di Torino, Turin). pp 251-60 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB–214(Vol.2); CONF-680629(Vol.2).

The latest developments of current algebra are discussed, particularly those concerning the contributions from the semi-disconnected graphs to the sum rules. A unified treatment of low-energy theorems and of the dispersive formulation of the sum rules is also presented. (auth)

5262 FUNDAMENTAL THEORY OF MATTER. A SURVEY OF RESULTS AND METHOD. Salam, Abdus (International Centre for Theoretical Physics, Trieste, Italy). pp 3-58 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB–214(Vol.2); CONF-680629(Vol.2).

The discussion covers classification of particles and charges, including Poincaré description, classification charges, distinguished particles and elementarity, relativistic quantum mechanics including kinematical considerations, ingredients of the theory, postulated canons of relativistic quantum mechanics, deductions from canons of relativistic quantum mechanics, hadron spectrum and the S-matrix program; the dynamical role of charges and sharing of currents between strong, weak and electromagnetic interactions, including dynamical role of charge, dynamical role of currents, universality of currents, low-frequency dynamics, particle spectrum and the symmetry algebra program, and the structure of hadrons, and still higher dynamical symmetries. (auth)

5263 THEORY OF SOURCES. Schwinger, J. (Harvard Univ., Cambridge, Mass.). pp 59-83 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB–214(Vol.2); CONF-680629(Vol.2).

The discussion covers source theory, application of the source theory to quantum electrodynamics, and strong interactions. (auth)

5264 COMPARISONS OF HYPOTHESIS AT CLOSE TO χ^2 MAGNITUDE. Silin, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 517-31 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Guidelines are given for setting up the problem for verifying and comparing various hypotheses. Comparison of theoretical and experimental data using the theory of probability was evolved for a hypothesis taken as a consequence of functions. (R.V.J.)

5265 INTERNATIONAL THEORETICAL SCHOOL ON HIGH ENERGY PHYSICS FOR EXPERIMENTALISTS, POPRADSKE PLESO, HIGH TATRA MOUNTAINS, CZECHOSLOVAKIA, 8–24 OCTOBER 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. 700p. (In Russian and English). (CONF-671087).

Separate abstracts are prepared for each of the 26 papers presented. (C.E.S.)

For abstracts of individual papers see: 4482–4487, 5240, 5249, 5264, 5276–5279, 5287, 5288, 5291, 5310–5314, 5322, 5328, 5339, 5367, and 5368.

Electromagnetic

Refer also to abstracts 5020, 5348, and 5359.

5266 (CEA-Bib-163) CYCLOTRONIC RESONANCE. Robert, Jean-Bernard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sep 1969. 24p. (In French). Dep. CFSTI (U. S. Sales Only).

Cyclotronic resonance makes use of the properties of motion of a charged particle subjected to two effects simultaneously: a constant magnetic induction and an alternating linear electrical field. Some applications of this technique which have been made in various fields are discussed including the study of interactions between electrons and neutral molecules, and between ions and neutral molecules in the gas phase; and the determination of reaction sequences, by double resonance. (auth)

5267 (NP-18074) ELECTROMAGNETIC MASS DIFFERENCES OF HADRONS. Note No. 231. Buccella, F.; Cini, M.; De Maria, M.; Tirozzi, B. (Rome Univ. (Italy). Istituto di Fisica). 10 Jul 1969. 40p. Dep. CFSTI (U. S. Sales Only).

Starting from the Cottingham formula, the problem of the $\Delta I = 1$ and $\Delta I = 2$ mass differences of the pseudoscalar and vector mesons, $(\frac{1}{2}^+)$ baryon octet and $(\frac{3}{2}^+)$ decuplet are examined in the framework of the Harari's approach. The Born and the transition terms of all these particles are calculated using a "low frequency" limit which comes essentially from the strong suppression of high q^2 values in the Cottingham integral due to the form factors; in this limit a "universal" relation is found between both the electric and the magnetic contributions of the Born terms to the two gauge-invariant parts of the forward nonspin flip amplitude for the Compton scattering. The residue function of the A_2 Regge pole $\beta(q^2)$ is calculated via F.E.S.R. for the Compton scattering of K mesons. The application of F.E.S.R. to (p-n) mass difference is critically examined. The connection with the residua of all the other particles is obtained with the use of the "universality" hypothesis for the coupling of A_2 Regge pole with mesons and baryons proposed by Cabibbo, Horowitz and Ne'eman. It is found that the inelastic terms thus evaluated always give a contribution of the right sign to the e.m. mass differences. The final numerical results are in very satisfactory agreement with experiment. (auth)

5268 PION-GAUGE CONDITIONS FOR ELECTRO- AND PHOTOPRODUCTION OF $N^*_{j=\frac{1}{2}}$ AND EQUALITY OF THE VECTOR AND AXIAL VECTOR FORM FACTORS. Barut, A. O. (Univ. of Ankara. Middle East Technical Univ., Ankara); Uenal, B. C. Nucl. Phys., B13: 622-8(1969).

General "self-consistency" conditions are derived for electro- and photoproduction amplitudes and coupling constants by the method of analytic continuation in mass, and by comparison with the PCAC results the equality $g_A(k^2)/g_A(0) = f_1^V(k^2)/f_1^V(0)$ is established. (auth)

5269 CALCULATIONS OF TRANSITION EFFECT IN ELECTRON–PHOTON SHOWER. Kol'chuzhkin, A. M.; Shevtsova, I. N. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 137-9(1969). (In Russian).

Considering first the transition effect for a plane two-layer absorber, the perturbation theory was used for studying the transition of an electron-photon shower passing through the boundary of two media. The development of the cascade from the source was followed in the plane two-layer absorber, taking into account the thicknesses of the layers. The formulas derived allowed one to determine the transition effect for showers generated by both electrons and γ quanta under consideration of the scattering of the particles. The disturbing layer may be either in front or behind of the main layer. Similar calculations were carried out for the transition effect for a shower generated by 1-GeV electrons in the lead-air and lead-copper systems, whereby the Compton scattering was neglected. (TTT)

5270 CURRENT-COMMUTATORS AND HIGH ENERGY HADRON PRODUCTION IN e^+e^- ANNIHILATION. Pestieau, J.; Roy, P. (Cornell Univ., Ithaca, N. Y.). Phys. Lett.; 30B: 483-7 (24 Nov 1969).

The asymptotic behavior of the structure-functions for the process $e^+e^- \to H$ + everything (where H is a detectable hadron) is considered in terms of commutators involving the electromagnetic current. (auth)

5271 GAUGE INVARIANCE, DUALITY, AND $N_\alpha - N_\gamma$ EXCHANGE DEGENERACY IN PHOTOPRODUCTION. Roy, D. P. (Univ. of Toronto). Phys. Rev. Lett.; 23: 1417-19(15 Dec 1969).

From gage invariance and duality an exchange degeneracy is obtained between N_α and N_γ contributions to pion photoproduction, which is exact for $u = M^2$ but approximate for $u \approx 0$. This may account for the absence of the wrong-signature dip in backward photoproduction. (auth)

5272 ELECTRODISINTEGRATION OF ^{3}H AND ^{3}He. Lehman, D. R. (George Washington Univ., Washington, D. C.). Phys. Rev. Lett.; 23: 1339-42(8 Dec 1969).

Two- and three-body electrodisintegration cross sections for ^{3}H and ^{3}He are calculated with nucleon-nucleon interactions represented by nonlocal, separable forms. Good agreement with experiment is obtained with Tabakin's ground state for the range of incident energies 250 to 550 MeV. (auth)

5273 RANGE ENERGY TABLES FOR HIGH ENERGY MUONS. Joseph, P. M. (Cornell Univ., Ithaca, N. Y.). Nucl. Instrum. Methods; 75: 13-17(1969).

Range energy tables for muons in aluminum, iron, copper, and lead are calculated using the Bethe–Bloch theory of ionization loss and Sternheimer's theory of the density effect. Values of range and dE/dx are tabulated for muon energies from 100 MeV to 50 GeV. Corrections for atomic binding, muon spin, nuclear excitation, bremsstrahlung and pair production are included. The calculations are based on, and compared with recent experimental data. (auth)

5274 STABILITY OF BUNCH OF HIGH-ENERGY PARTICLES IN STATISTICALLY INHOMOGENEOUS MEDIA. Begiashvili, G. A.; Monin, Yu. S. Soobshch. Akad. Nauk Gruz. SSR; 55: 557-60(Sep 1969). (In Russian).

The passage of an infinite compensated bunch of high-energy particles through statistically inhomogeneous dielectric media is considered. It is revealed that in consequence of the original transitional radiation of electromagnetic waves by the high-energy particles of the bunch on the medium inhomogeneity the bunch appears to be unstable at the speeds lower than the Cherenkov radiation threshold. (auth)

5275 RADIATIVE VECTOR AND PSEUDOSCALAR MESON DECAYS. APPLICATION TO THE $e^+e^- \to \eta\gamma$ REACTIONS. Cremmer, E. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B14: 52-62(1969).

The radiative vector and pseudoscalar meson decay widths are calculated using vector-meson dominance model, SU(3) symmetry and taking into account $\omega - \Phi$ and $\eta - X_0$ mixings. The results are applied to the calculation of the cross section for the annihilation $e^+e^- \to \eta\gamma$. (auth)

Weak

Refer also to abstract 5338.

5276 SOME PROBLEMS IN THE THEORY OF WEAK INTERACTIONS. Yanoukh, F. (Inst. of Nuclear Research, Rez, Czech.). pp 149-72 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The report on the theory of weak interactions was confined to the data covering the principal properties of weak interactions and general form of the Hamiltonian; weak interaction classifications, conservation laws and weak interaction symmetry, effective weak interaction Hamiltonian, hypothesis on vector current conservation, radiative corrections to weak interactions and a short review of a few new works. (R.V.J.)

5277 LEPTON CHARGE CONSERVATION PROBLEM. Pontekorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 483-96 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Lepton charge conservation was examined considering the selection rules, breakdown of lepton conservation, double β decay and processes of $\nu_e + p \to e^+ + n$, $\mu \to e + \gamma$, $\mu^- + Z \to (Z-2) + e^+$ types. The possible oscillations of $\nu \rightleftharpoons \bar{\nu}$, $\nu_\mu \rightleftharpoons \nu_e$ in a vacuum and various methods for observing neutron oscillations, time and length of oscillations and oscillations $\nu \rightleftharpoons \bar{\nu}$ in astronomy are discussed. (R.V.J.)

5278 μ-MESON (THE μ-e PROBLEM). Markov, M. A. (Inst. of Physics, Moscow). pp 173-87 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The theory of elementary particles was briefly analyzed considering various physical properties of the μ-meson and electron and their position in the systematics of elementary particles. The m_μ and m_e problem is extensively explored. It was suggested that verification of μ-data in precision experiments carried out in accelerators and various studies of cosmic ray μ physics will contribute to the concept of $m_\mu - m_e$ problem. (R.V.J.)

5279 DECAY OF K^0 MESONS AND CONSERVATION LAWS. Lapidus, L. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 111-47 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Data on decay of K^0 mesons are briefly discussed considering CP-invariance, unitarity, isospin analysis of $K^0 \rightarrow 2\pi$ decay, and decay amplitudes including some data obtained with 10 GeV and 7 GeV accelerators. Data on the interference of K_2^0 and K_1^0 in two pion decay were also reported. (R.V.J.)

5280 ELEMENTARY PARTICLE APPROACH TO MUON CAPTURE. Galindo, A. (Facultad de Ciencias, Madrid); Pascual, P. Nucl. Phys.; B14: 37-51(1969).

A new formulation of the theory of muon capture, when all intervening particles are treated as elementary particles, is presented. Using the covariant spin formalism invariant form factors are introduced. The hyperfine effects are taken into consideration and the formula for the asymmetry parameter is given. The theory is applied to several cases. (auth)

5281 ON THE INDUCED PSEUDOSCALAR COUPLING IN μ-CAPTURE. Wycech, S. (Univ. of Copenhagen). Nucl. Phys.; B14: 133-42(1969).

The value of induced pseudoscalar coupling F_P in nuclear μ-capture is studied. The PCAC hypothesis brings about a renormalization of F_P due to the form of the pionic propagator in nuclei. This effect is estimated on the statistical model of nuclei to be $\approx 50\%$ of F_P measured in the free proton case. (auth)

Strong (General)

Refer also to abstracts 5239 and 5317.

5282 (DESY-69/38) ON A NEW PERIPHERAL MODEL. Dar, A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1969. 25p. (CONF-690914-4). Dep. CFSTI (U. S. Sales Only).

From 3rd International Conference on High Energy Physics and Nuclear Structure, New York.

A new peripheral model for high-energy exchange reactions of Dar Watts and Weisskopf is briefly reviewed. It is shown that the model provides a simple explanation for the presence of spikes and dips in the t dependence of many cross sections on one hand, and for their absence in many other cross sections, on the other hand. (auth)

5283 LONGITUDINAL MOMENTUM DISTRIBUTION OF PIONIZATION PRODUCTS. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev. Lett.; 23: 1311-13(1 Dec 1969).

A quantitative formula for the distribution of pionization products in ultrahigh-energy scattering is obtained on the basis of general principles only as a function of the longitudinal momentum. Field theory is then used as a model to show the existence of the pionization process, and it also serves as an example in which the formula is satisfied. A highly feasible storage-ring experiment is proposed to test this predicted distribution and hence the underlying principles. (auth)

5284 INELASTIC COLLISIONS OF HADRONS AND THE MULTI-REGGE MODEL. Chan, Hong-mo (CERN, Geneva). Rep. Progr. Phys.; 32: 607-31(Oct 1969).

A review is given of the phenomenological work done on particle production processes in the year 1967–68. The unusual activity in this subject during that period was due to the emergence of first a large amount of good-quality new bubble chamber data and second, practical forms of the multi-Regge model. The result is a consistent, though crude picture, of inelastic collisions in general. This resultant picture is presented with ample illustrations from existing data, but with no attempt at completeness. Later developments are also briefly indicated. (auth)

5285 DYNAMICS OF STRONG INTERACTIONS AND THE S-MATRIX. Omnes, R. (Univ. de Paris, Orsay, France). pp 145-9 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The physical principles underlying the S-matrix theory of strong interactions are reviewed. In particular, the problem of whether these principles are sufficient to completely determine the S-matrix, i.e., to yield a dynamical theory of strong interactions, is discussed. (auth)

5286 HIGH-ENERGY COLLISIONS OF HADRONS: WHAT ARE THE DYNAMICAL MECHANISMS. Van Hove, L. (CERN, Geneva). pp 107-21 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

A survey is given of the two dominant mechanisms which have been recognized to operate in high-energy collisions of hadrons, namely diffraction scattering and Reggeized particle exchange. The main characteristics of these mechanisms are discussed on the basis of the experimental evidence from two-body processes. The complicating features which occur at a higher level of precision are briefly discussed. A descriptive treatment rather than the theoretical formalism is given. (auth)

5287 BOOTSTRAP METHOD. RESONANCE AND RELATED STATES. Isaev, P. S. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 339-59 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The principal concepts of bootstrap and the results obtained by means of bootstrap methods are reviewed. Dynamic mathematical bootstrap equations are analyzed and various shortcomings of bootstrap methods are criticized. (R.V.J.)

5288 RECENT DEVELOPMENTS OF THE REGGE POLE THEORY OF HIGH ENERGY ELEMENTARY PARTICLE INTERACTIONS. Suranyi, P. (Central Research Inst. of Physics, Budapest). pp 93-110 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967.

See CONF-671087.

Rather than giving a full account of the present status of the theory, some points are emphasized in which there are open questions and where further experimentation is needed. Forward scattering, production, O(4) symmetry, the $t < 0$ domain, ghosts, and dips in the differential cross section, the region $t \sim -s$, and inelastic processes are covered. (J.F.P.)

5289 VERY HIGH-ENERGY COLLISIONS OF HADRONS. Feynman, Richard P. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 23: 1415-17(15 Dec 1969).

Proposals are made predicting the character of longitudinal-momentum distributions in hadron collisions of extreme energies. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 5240.

5290 (NYO-2262-TA-211) LOW-ENERGY PARAMETERS FOR MESON–MESON SCATTERING FROM THE VENEZIANO MODEL. Kang, Kyungsik; Raman, K. (Brown Univ., Providence, R. I. Dept. of Physics). July 1969. 19p. Dep. CFSTI.

Low-energy parameters for $\pi\pi$ and $K\pi$ scattering are obtained using the Veneziano model and different assumptions for the input Regge parameters of the ρ trajectory. It is shown that two classes of solutions are obtained, depending on the input ρ trajectory used. These are compared with each other; it is pointed out how they may be distinguished experimentally. (auth)

5291 ANNIHILATION IN FLIGHT. Simak, V. (Inst. of Physics, Prague). pp 415-48 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967.

See CONF-671087.

The discussion of annihilation in flight includes annihilations and interactions, annihilation of nucleons and selection rules, the statistical theory of annihilation, correlation effects in the pion–pion final-state, production of resonances, and angular distribution of secondary mesons in the cms. Also discussed are the theoretical approach to annihilation, the quark model for annihilation at low energy and at high energy, and general tests in annihilation. (J.F.P.)

5292 CONTINUOUS BREAKING OF CHIRAL SYMMETRY. Okubo, S.; Mathur, V. S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 23: 1412-15(15 Dec 1969).

Continuity arguments for transitions between various subgroups of the chiral-symmetry group are presented. Some interesting sum rules are obtained in this way. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 5337.

5293 (NYO-2262-TA-207) FIELD THEORETIC MODEL FOR HIGH ENERGY SCATTERING. II. EFFECTIVE REGGE EXCHANGE IN π N SCATTERING. Fried, H. M. (Brown Univ., Providence, R. I. Dept. of Physics). [1969]. 34p. Dep. CFSTI.

A field-theoretic calculation of πN scattering, combining soft, virtual, neutral vector meson exchange with simple nucleon, 3-3 resonance and ρ poles, is shown to produce amplitudes containing both fixed and Regge poles, yielding polarizations and differential cross sections with a qualitative resemblance to recent experiments. (auth)

5294 PION-NUCLEON SCATTERING. Conference Held December 1–2, 1967, Irvine, California. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969. 241p. $16.50. (CONF-671203).

Twelve papers are included, which represent the nine summary talks and parts of the panel discussion that followed the contributed papers. Eleven papers are abstracted for NSA. The paper not abstracted consists of brief comments concerning the possibility of representing certain phenomena alternately as resonances or as peripheral phenomena. An introduction is presented, which includes a numerical table of πN kinematics and a number of relations relevant to πN scattering. (L.B.S.)

For abstracts of individual sections see: 5295–5305.

5295 πp ELASTIC SCATTERING: LOW ENERGY EXPERIMENTS AND PHASE SHIFT ANALYSES. Johnson, Claiborne; Steiner, Herbert (Univ. of California, Berkeley). pp 1-26 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN scattering, Irvine, Calif. See CONF-671203.

The present status of πp elastic scattering experiments below $p_\pi \sim 2$ GeV/c is discussed. The methods, results, and some of the problems of various phase shift analyses are reviewed. (L.B.S.)

5296 πN PHASE SHIFT ANALYSIS AND PHENOMENOLOGICAL DISPERSION RELATIONS. Lovelace, C. (CERN, Geneva). pp 27-45 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

The methods used in solving the equations involved in the πN phase shift analysis are discussed. The derivation and evaluation of backward and forward dispersion relations and the evaluation of partial wave dispersion relations are reviewed. (L.B.S.)

5297 N* STUDIES VIA πp INELASTIC REACTIONS. Rosenfeld, Arthur H.; Soeding, Paul H. (Univ. of California, Berkeley). pp 47-80 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

A brief survey is given of inelastic cross sections and bubble chamber experiments for π^-p and π^+p interactions. A summary is given of the information obtained so far from the inelastic final states of N* resonances when these are formed in the s channel. Useful information which may be expected in the next year on branching ratios and signs of amplitudes and their relation to SU(3) classification are also discussed. (L.B.S.)

5298 STRUCTURE OF THE DIFFERENTIAL CROSS SECTION AT HIGH ENERGY. Ross, Marc (Univ. of Michigan, Ann Arbor). pp 131-9 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

Two processes which give a qualitative explanation of the structure in the high energy πN differential cross section are discussed: multiple scattering among the parts of composite particles; and S-channel resonances and the new bootstrap between them and exchanged trajectories. The Regge formalism which is also used to describe the structure is briefly mentioned. (L.B.S.)

5299 REGGE POLES AND HIGH ENERGY πN SCATTERING. Frautschi, Steven (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. pp 141-54 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

Analogous attempts to understand high energy πN scattering by means of Regge poles are reviewed. The Regge pole expansions for the crossed (t) and crossed (u) channels are used to fit the forward angle and backward angle scattering, respectively. (L.B.S.)

5300 THE RELATIONS BETWEEN PCAC, AXIAL-CHARGE COMMUTATION RELATIONS, AND CONSPIRACY THEORY. Mandelstam, Stanley (Univ. of California, Berkeley). pp 167-86 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

It is shown that all restrictions which PCAC and current commutators have so far provided on hadron scattering amplitudes can also be obtained from analyticity and unitarity, provided that the pion trajectory has the conspiracy quantum number $|M| = 1$. It is discussed whether the existence of massless particles satisfying the Adler self-consistency condition implies the existence of a conserved axial current. The axial-current commutation relations are examined, and it is shown that most intermediate states give no contribution to the matrix element of the commutator of two axial charges. (L.B.J.)

5301 PARTIAL WAVE DISPERSION RELATIONS AND N/D CALCULATIONS. Shaw, Gordon L. (Univ. of California, Irvine). pp 115-30 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

The dynamical attempts to understand low-energy phenomena of πN scattering using partial wave dispersion relations are reviewed. One- and two-channel N/D models for analyzing πN partial wave phase shifts are discussed. (L.B.S.)

5302 FORWARD DISPERSION RELATIONS: THEIR VALIDITY AND PREDICTIONS. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). pp 81-113 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

The predictions and experimental tests of forward dispersion relations for πN scattering are reviewed. Topics discussed include πN forward dispersion relations, asymptotic bounds on total cross sections, early applications, comparison with experimental results, fundamental length, charge independence, pp and $\bar{p}$p forward scattering, and asymptotic behavior of total cross sections. (L.B.S.)

5303 CURRENT ALGEBRA DETERMINATION OF LOW-ENERGY πN PARAMETERS. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass.). pp 155-65 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

The extension of the current-algebra method to the prediction of low energy πN parameters is studied within the framework of the Weinberg presentation for soft pions. Predictions for the S-wave scattering lengths and the Adler–Weisberger relation are in good agreement with experiment. (L.B.S.)

5304 EXCITED NUCLEONS AND THE BARYONIC SUPERMULTIPLETS. Dalitz, R. H. (Oxford Univ.). pp 187-207 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

A survey is made of the excited nucleon states given by a phase shift analysis of πN scattering and polarization data up to 2000 MeV cm energy. It is shown that all of the levels together with the two Y_0^* singlet states can be assigned to SU(6) supermultiplets with $(L,\omega) = 0+$, 1-, or 2+. The sequence of orbital excitations

L = 0+, 1-, 2+ and of SU(6) representations follows naturally the sequence expected for the shell-model states appropriate to a three-quark system. (L.B.S.)

5305 REMARKS ON LOW-ENERGY πN SCATTERING. Sakurai, J. J. (Univ. of Chicago). pp 209-13 of Pion–Nucleon Scattering. Shaw, Gordon L.; Wong, David Y. (eds.). New York, John Wiley and Sons, Inc., 1969.

From Conference on πN Scattering, Irvine, Calif. See CONF-671203.

It is pointed out that the advances in PCAC and current algebra in the past few years essentially justify the 1960 conjecture that the low-energy scattering amplitude is due to the nucleon Born term computed according to the gradient coupling prescription plus the ρ exchange term computed in accordance with the universality principle. Results for the symmetric and the antisymmetric part of the s-wave scattering lengths are discussed. (L.B.S.)

5306 TEST OF (ρ,A_2) EXCHANGE DEGENERACY, DUALITY, AND EVIDENCE FOR SECONDARY TRAJECTORIES OBTAINED FROM (KN, $\bar{K}$N) CHARGE-EXCHANGE REACTIONS. Cline, D. (Univ. of Hawaii, Honolulu); Matos, J.; Reeder, D. D. Phys. Rev. Lett.; 23: 1318-21(1 Dec 1969).

An analysis of the difference between the charge-exchange reactions $K^+n \rightarrow K^0p$ and $K^-p \rightarrow \bar{K}^0n$ over the momentum range 1 to 5.5 GeV/c provides strong evidence for exchange degeneracy of the (ρ,A_2) trajectories and shows the importance of the exchange of secondary trajectories. The energy dependence of this difference is shown to be inconsistent with simple cut models. A new test of the duality principle is proposed and appears to be in good agreement with the present data. (auth)

5307 DUALITY IN $\pi^- + p \rightarrow \pi^+ + \Delta^-$ AT 1.5 TO 1.8 GeV. Kernan, A. (Univ. of California, Riverside); Shepard, Harvey K. Phys. Rev. Lett.; 23: 1314-17(1 Dec 1969).

Considerable evidence for duality is found in a study of the amplitude for $\pi^-p \rightarrow \pi^+\Delta^-(1236)$ scattering at center of mass energies 1.5 to 1.8 GeV. Cancellation between dominant contributions from the $\frac{5}{2}^+$, $F_{15}(1690)$ and the $\frac{3}{2}^-$, $D_{13}(1520)$ is primarily responsible for the local averaging. (auth)

5308 ASYMPTOTIC ENERGIES. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). pp 123-43 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB–214(Vol.2); CONF-680629(Vol.2).

The problem of estimating "asymptotic energies" for at least the gross features of strong interactions is considered in historical perspective. It is shown experimentally that the pion-nucleon forward dispersion relations are valid to beyond 20 GeV/c and that they can serve as a crystal ball to estimate at what energy various asymptotic theorems, such as the Pomeranchuk theorem, will come true. It is concluded that the experimental data strongly imply the validity of the Pomeranchuk theorem and that it is estimated to come true to within the best foreseeable experimental precision (0.1% cross section measurements) at beyond 20,000 GeV; on the basis of various models for formulating a fundamental length $|l|$, if it exists, $|l| < 10^{-15}$ cm, and probably $< 10^{-16}$ cm; forward elastic pion-nucleon scattering amplitudes are analytic to the highest energies (~20 GeV) measured, and that the predictions of unitarity, crossing symmetry, and charge independence are valid for these amplitudes and their behavior is consistent with the Froissart bound and the Pomeranchuk theorem. (auth)

5309 FROM CHIRAL DYNAMICS TO CHIRAL ALGEBRA. Weinberg, S. (Massachusetts Inst. of Tech., Cambridge. Univ. of California, Berkeley). pp 261-9 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

An attempt is made to reconcile two views on chiral symmetry. Starting with chirality as a dynamical symmetry, its algebraic aspects are derived by using dispersion theory on the phenomenological Lagrangian method. (auth)

5310 REGGE POLE ASYMPTOTIC (INTERACTION AT HIGH ENERGY). Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). pp 43-91 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The Regge pole asymptotic, resonance state, concrete formulas and branching were briefly reviewed. Experiments used in studies of branching included the determination of Orear's distribution at high energy in πN elastic and charge exchange scattering, measurements of the spin flip in NN-elastic scattering and charge-exchange in reactions $\pi^-N \rightarrow f^0N$, $\gamma p \rightarrow \pi^+n$, and measurements of polarization from π^-p-scattering at high energy. (R.V.J.)

5311 DETERMINATION OF QUANTUM NUMBERS FOR UNSTABLE PARTICLES. Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 449-82 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

A determination of the quantum numbers for fermion resonances appearing as intermediate states in two-particle reactions of the $a + C \rightarrow A^* \rightarrow c + d$ type and a discussion of the spin and parity of fermion resonances generated in reactions of $a + C \rightarrow A^* + c + \ldots$ type decaying according to the scheme $0 + \frac{1}{2}$ (0 and $\frac{1}{2}$ are the spins of decay products) were presented. In addition the methods for determining spins and parities of boson resonances were briefly reviewed. (R.V.J.)

5312 EXPERIMENTAL INVESTIGATION OF HIGH-ENERGY NUCLEAR INTERACTIONS WITH SMALL MOMENTUM TRANSFER. PART I. ELASTIC SCATTERING AT HIGH ENERGY IN THE REGION OF COULOMB AND NUCLEAR AMPLITUDE INTERFERENCE. PART II. APPLICATIONS OF COHERENT PION REACTIONS WITH NUCLEI DURING INVESTIGATION OF ELEMENTARY PARTICLE INTERACTIONS AT HIGH ENERGIES. Strunov, L. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 637-64 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Determination of the amplitude of πN scattering was discussed as the primary topic. Measurements of the amplitude phase in elastic πp-scattering in the $t \sim 0$ experiments for pion scattering on nucleons in the region of t transfer with interference between Coulomb and nuclear amplitudes were analyzed and related problems for verification of dispersion relation are discussed. The perspectives of using coherent pion reactions in nuclei (such as ^{4}He) in order to obtain information on the amplitude of πN scattering are estimated. Methods and experimental verifications of nuclear calculations based on Glauber methods are discussed. (R.V.J.)

5313 SPIN DEPENDENT EFFECTS IN πN AND NN INTERACTIONS. Steiner, H. (Univ. of California, Berkeley). pp 205-39 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech. Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967.

See CONF-671087.

The basic formalism and experimental situation is outlined for πN interactions at resonance energies. Also crucial tests of high-energy theories from various spin-dependent quantities in πN and NN scattering are considered. (J.F.P.)

5314 NEW DATA ON QUARK MODELS. Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 361-77 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8–24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Various results obtained by means of the quark composite model of elementary particles are developed. The analysis was confined to the more simplified baryon quark model similar to that of a shell model for atomic nuclei. Instead of considering the problem as a bound state of three quark systems in strong interaction with each other, the quarks in baryons are considered as independent particles moving in a self-consistent field. (R.V.J.)

5315 POMERANCHUK THEOREM AND K_L-K_S REGENERATION. Kleinknecht, K. (CERN, Geneva). Phys. Lett.; 30B: 514-16(24 Nov 1969).

A sensitive test of the Pomeranchuk theorem can be performed by measuring the interference effects between $K_S \rightarrow \pi^+\pi^-$ and $K_L \rightarrow \pi^+\pi^-$ behind a regenerator at 20 to 60 GeV/c. This method gives not only the total cross-section differences between K^0 and $\bar{K}^0$ on nucleus, but also the difference of the real parts of the K^0, $\bar{K}^0$ forward scattering amplitudes. (auth)

5316 MODEL FOR HIGH-MULTIPLICITY πp INTERACTIONS. Zieminski, A. (Univ., Warsaw). Nucl. Phys.; B14: 75-90(1969).

The transition matrix element S for high multiplicity reactions $\pi p \rightarrow p + (N - 1)\pi$ is assumed to depend only on the four-momentum transfer, t, from the initial to the secondary nucleon. A method of deriving the so-called F(t) function giving the empirical form of the averaged t-dependence of the matrix element for many-body processes is described. It is shown that in the GeV region F(t) resembles the differential cross section, $d\sigma/dt$ of the two-body processes. It is also shown that F(t) depends strongly on the incident pion energy and on the multiplicity. The experimental single particle distributions for pions and nucleons are compared with the predictions of the proposed F(t) model. (auth)

5317 MASS DEPENDENCE OF THE DIFFRACTION PEAK IN RESONANCE PRODUCTION AND THE MULTIPOINT VENEZIANO MODEL. Wlatz, R. E. (Univ. of Chicago). Phys. Lett.; 30B: 490-3(24 Nov 1969).

It is shown that the multipoint Veneziano model predicts that the diffraction peak in resonance production should smoothly broaden as the resonance mass increases in qualitative agreement with experiment. Comparisons with "non-dual" models are made. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 5302.

5318 (UCRL-50706) A FORM-FREE, SEMIPHENOMENOLOGICAL, ERROR-BOUNDED, POTENTIAL REPRESENTATION OF TWO-NUCLEON EXPERIMENTS. Stone III, Samuel Rollins (California Univ., Livermore. Lawrence Radiation Lab.). 14 Jul 1969. 134p. Dep. CFSTI.

Thesis.

A study is made of how to obtain the most general potential which describes two-nucleon experiments. Motivation is to find the potential, not assuming a functional form, dictated entirely by experimental data. The background, new developments, and conceptual components of a scheme which determines the potential from data are presented. The scheme is applied to proton-proton scattering and a potential is obtained in a numerical form which is designed for most rapid use by digital computer. A potential is sought for use in the Schrödinger equation. Only the usual invariance principles are assumed. The usual one-pion-exchange contribution (whose strength is not assumed), and moderate energies of interaction corresponding to laboratory beam energies less than 500 MeV. The potential so obtained has full generality as a spinor- and isospinor-operator. It is explicitly local, but nonlocality is accounted for through dependence on energy. It accounts for relativistic effects, mass splitting of pi mesons and of nucleons, lowest-ordered effects of magnetic moments and of extended nucleon size, and the proton-proton Coulomb force including the Uehling vacuum polarization correction. The scheme seeks a potential which is specifically designed for most rapid use by digital computer. Since wave functions, phase shifts, and scattering matrix elements depend on integrals of potential, a numerical quadrature is devised for maximum speed and accuracy. The quadrature, a Gaussian type, permits computation speed nearly two orders of magnitude faster than conventional integration of coupled, differential, Schrödinger equations. A precise numerical expression is given for vacuum polarization correction to proton-proton scattering. Finally, the scheme produces not only the potential in numerical form but also error bounds. For each numerical value of potential, the corresponding error bound is the statistically expected uncertainty. The scheme is applied to proton-proton scattering. Four separate solutions are obtained for the proton-proton, nuclear potential. The solutions differ in spinor-operator and energy forms. Each of the four numerical solutions is error-bounded. Each is well-fitted to experiment; chi-squared per datum is 1.89, 2.03, 5.22, and 5.63. The solutions approximate potentials predicted by one-boson-exchange, but the agreement is only qualitative. It is concluded that energy dependence is necessary for two-nucleon potentials. There seems little need for quadratic spin-orbit dependence. (auth)

5319 LARGE-MASS TIMELIKE MUON PAIRS IN HADRONIC INTERACTIONS. Berman, S. M.; Levy, D. J.; Neff, T. L. (Stanford Univ., Calif.). Phys. Rev. Lett.; 23: 1363-5(8 Dec 1969).

Utilizing a simple field-theoretic model, the production of timelike muon pairs is considered via a massive virtual photon in high-energy hadronic collisions. The differential cross section in the squared mass of the muon pair is predicted as well as the total cross section. It is found that the form factors do not possess the analog of the Bjorken scaling associated with deep inelastic electron scattering, but are scale functions multiplied by the usual bremsstrahlung factor $\langle t_{av} \rangle/s$. (auth)

Particle Invariance Principles and Symmetries

Refer also to abstract 5260.

General

5320 PHYSICAL REALIZATION OF NONCOMPACT DYNAMICAL SYMMETRIES. Katriel, J.; Adam, G. (Nuclear Research Centre-Negev, Beer-Sheva, Israel). Phys. Rev. Lett.; 23: 1310-11(1 Dec 1969).

The dynamical symmetry of a charged spinless harmonic oscillator in a constant magnetic field is identified. For low fields it is SU(3), for high fields SU(2,1), and for a certain definite intermediate field $SU(2) \otimes H$. (auth)

5321 INFINITE MULTIPLETS IN ATOMIC AND HIGH-ENERGY PHYSICS. Fronsdal, C. (Univ. of California, Los Angeles). pp 211-18 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The hydrogen atom and relativistic theories are discussed. (auth)

5322 SYMMETRY PROPERTIES BASED ON DISCRETE TRANSFORMATIONS ((C,P,T) TRANSFORMATIONS AND THEIR COMBINATIONS). Arbuzov, B. A. (Inst. of High Energy Physics, Moscow). pp 189-203 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

The problems on discrete symmetries were studied: space reflection, time conversion, operation of charge conjugation, and their products. Data are given on determination of these operations and the cases with precise and suitable quantum numbers, the Lueders theorem on CPT invariance and symmetry breakdown, violation of combined CP inversion and determination of the P, C, and T. (R.V.J.)

Applications (Electromagnetic and Weak)

5323 WEAK INTERACTIONS AND CPT ASYMMETRIES. Lee, T. D. (Columbia Univ., New York). pp 283-96 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

General symmetry properties of weak interactions, CP asymmetry, phenomenological Lagrangian and its selection rules, and limitation of Fermi's theory and higher-order weak interactions are treated. (auth)

Applications (Strong)

Refer also to abstract 5333.

5324 (NP-18078) A GROUP THEORETICAL APPROACH TO THE MULTIPERIPHERAL MODEL. Note No. 235. Ferrara, S.; Mattioli, G. (Rome Univ. (Italy). Istituto di Fisica). 27 Jul 1969. 34p. Dep. CFSTI (U. S. Sales Only).

The convergence of the multiperipheral series is investigated in the case of the scattering of two spinless particles, when the square of the space-like momentum transfer W is fixed as a parameter. A "coupling scheme" is introduced in which the scattering amplitude is described as a pseudobilinear functional on some Hilbert spaces which contain elements describing an incoming and an outgoing particle. So in this formalism to every multiperipheral graph is associated a pseudobilinear functional. The properties of the series are studied by means of the "crossed" partial wave analysis. Using Fredholm techniques and analyticity properties it is shown that the graph series sum, in correspondence to physical values of the coupling constant g, is described by an unbounded functional which cannot be expressed only by means of the unitary irreducible representations of the principal series of O(2,1). In this formalism this means that the amplitude contains some Regge pole contributions. The Regge asymptotic behavior of the solution and a new formulation of the Froissart bound are pointed out. The usefulness of the method is discussed for the ladder approximation case. (auth)

5325 QUARKS, THE HADRONIC SUB-UNITS. Dalitz, R. H. (Oxford Univ.). pp 219-47 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The evidence is reviewed that the spectrum of hadronic states corresponds to a series of SU(6) (spin × unitary spin) supermultiplets $(a, L(-1)^L)_n$, with orbital (L, with parity P) and radial (n) excitations, their unitary submultiplets having total spin $\vec{J} = \vec{L} + \vec{S}$. Two mixed supermultiplets $(\underline{35} + \underline{1}, L(-1)^L)_n$ appear rather clearly for the mesons, for n = L = 0 and for n = L = 1 (possibly another for n = L = 2, and an n = 2 radial excitation for L = 0). Below 2 GeV, five baryonic supermultiplets occur, $(\underline{56}, 0+)_n$ with n = 0, 2 and 4, $(\underline{70}, 1-)_1$ and $(\underline{56}, 2+)_2$; the nucleonic member was identified for each unitary supermultiplet (Y_0^* for unitary singlets), except for two ($\frac{3}{2}$+) decuplets. The hypothesis that hadronic supermultiplets correspond to tight-bound systems of quark-triplets would account qualitatively for many of their outstanding features; no established states lie outside the supermultiplets then possible, and the L and n excitations would have direct physical interpretation. The low-lying baryonic supermultiplets agree (in quantum numbers and order of excitation energy) with the harmonic shell-model states which Greenberg discussed in 1964 assuming symmetric wavefunctions (parastatistics). With a further additivity assumption, this quark model leads directly to several outstanding features of high-energy collisions. Theoretical difficulties faced by this naive quark model are discussed. (auth)

5326 THEORY AND APPLICATIONS OF UNITARY SPIN. Ne'eman, Y. (Tel-Aviv Univ., Israel). pp 167-92 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The discussion of unitary spin covers the abstract Lie algebra of SU(3), particle assignments, unitary symmetry and strong-interaction intensity rules, breaking SU(3) and the Gell-Mann and Okubo mass formulas, electromagnetic transitions, universality of the atonous currents, nonleptonic atonous interactions, a current-generated algebra and chiral $[U(3) \times U(3)]_{\gamma_5}$, the strong interactions, origin of SU(3) and its breaking, observing a strongly-coupled current, and the nature of the fixed pole of Abarbanel et al. (auth)

5327 SU(6) SYMMETRY AND ITS RELATIVISTIC GENERALIZATIONS. Guersey, F. (Middle East Technical Univ., Ankara). pp 193-210 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The discussion includes the origins, the heuristic SU(6) symmetry, vertex symmetry, applications of the heuristic formulation, different languages for SU(6), attempts at formulations of SU(6) within field theory, comparison with chiral groups, possible new limit for exact SU(6) symmetry, a specific model, decoupling of spin from orbital angular momentum, realization of SL(4,C) in Hilbert space, current algebra, and the outlook. (auth)

5328 BREAKDOWN OF HIGHEST SYMMETRIES AND NONET PSEUDOSCALAR MESONS. Laslavskii, A.; Ogievetskii, V.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 325-37 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

It is pointed out that within the limits of broken $SU(6)_w$ symmetry the 9th pseudoscalar meson should be the E(1420) meson and not the X(960) meson. It is also indicated that the pseudoscalarity of the X(960) meson should not be considered as determined experimentally and additional data are required for determining the spin-parity of the X meson. Certain relations in broken $SU(6)_w$ for E-meson production in meson-nucleon collisions are suggested and compared to the experimental data. Considering that $SU(6)_w$ contains a unitary symmetry SU(3) a brief review is also given on the breakdown in unitary symmetry and the importance of SU(3) in mass formulas and reaction amplitudes. Nonet pseudoscalar and vector mesons are discussed as well as the octet $\frac{1}{2}^+$ and baryon resonance decouplet $\frac{3}{2}^+$. (R.V.J.)

5329 NON-LOCAL REALIZATION OF CHIRAL SYMMETRY. Prokhorov, L. V. (Imperial Coll. of Science and Technology, London). Nucl. Phys.; B14: 208-18(1969).

It is shown that there exists a non-local, non-hermitian, effective Lagrangian giving in the tree approximation a description of scattering phenomena correct at all energies. Because such a Lagrangian cannot be invariant under the ordinary local, nonlinear realization of chiral symmetry a non-local realization of chiral $SU_2 \times SU_2$ is introduced and its consequences are studied. (auth)

Field Theories

Refer also to abstract 5260.

Quantum Field Theory

Refer also to abstracts 5227–5229, 5259, 5262, 5263, and 5293.

5330 (BMwF-FBK-69-30) QUANTIZED FIELDS AS OPERATOR-VALUED DISTRIBUTIONS. Westenholz, C. v. (Muenster Univ. (West Germany). Institut fuer Theoretische Physik). Oct 1969. 10p. (In German). Dep. CFSTI (U. S. Sales Only).

A class of operator-valued fields are defined over a function-space of the test functions, and these fields are considered as representatives of all free quantum fields. Then some postulates of the axiomatic quantum field theory are proved, such as the existence of a continuous expectation functional $W(f) = (\psi, A(f)\phi)$. (auth)

5331 (LAL-1221) Q.E.D. TEST BY e^+e^- SCATTERING AT 2 x 510 MeV. Augustin, J. E.; Buon, J.; Delcourt, B.; Jeanjean, J.; Lalanne, D.; Ngoc, H. Nguyen; Perez-y-Jorba, J.; Richard, F.; Rumpf, F.; Treille, D. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Sep 1969. 19p. Dep. CFSTI (U. S. Sales Only).

Elastic electron-positron scattering was studied at a cms energy of 2 × 510 MeV. Large-angle scattering events registered using scintillation counters and spark chambers. The results for the cross sections provide a test of quantum electrodynamics. (J.F.P.)

5332 (NYO-2262-TA-214) NON-COMMUTATION REQUIREMENTS AND FIELD DEPENDENCE OF SOURCES OF TENSOR FIELDS. Raman, K. (Brown Univ., Providence, R. I. Dept. of Physics). Sept. 1969. 20p. Dep. CFSTI.

Starting with the noncommutation requirements among different components of a conserved source tensor for a massive spin-two field, the resulting noncommutation requirements between the source and the field variables, and the field dependence of the source that this necessitates are discussed. (auth)

5333 WAVE EQUATIONS FOR INFINITE-COMPONENT FIELDS. Budini, P. (International Centre for Theoretical Physics, Trieste, Italy). pp 249-50 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

It is shown that when the internal motion can be described by algebraic methods, the proposed equation for the motion of the system as a whole is equivalent to a Majorana-type equation. (auth)

5334 QUANTUM FIELD THEORY. INTRODUCTORY REMARKS. Haag, R. (Univ., Hamburg). pp 459-62 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

A brief account is given of the major changes in the understanding of the general principles of quantum physics, invariance under Lorentz transformations and translations in space-time, locality and causality, and stability during the past decade. (auth)

5335 PROGRESS IN CONSTRUCTIVE FIELD THEORY. Jaffe, A. M. (Harvard Univ., Cambridge, Mass.). pp 463-9 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The $(\phi^4)_2$ theory, time translation without cut-offs for $(\phi^4)_2$, the vacuum state and Hamiltonian for $(\phi^4)_2$, the $(\bar{\Psi}\Psi\phi)_2$ theory, and the $(\phi^4)_3$ theory are considered. (auth)

5336 FIELD THEORY AND STATISTICAL MECHANICS. Ruelle, D. (IHES, Bures-sur-Yvette, France). pp 471-5 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

Systems with an infinite number of degrees of freedom (SINDFs), a proposed study of SINDFs by rigorous mathematical techniques, the states of SINDFs, equilibrium states of infinite systems in statistical mechanics, existence problem in local field theory, phenomenological analogies between SINDFs, breakdown of symmetry, and Thom's theory of morphogenesis are considered. (auth)

5337 PHENOMENOLOGICAL LAGRANGIANS. Zumino, B. (New York Univ., N. Y.). pp 271-81 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

Nonlinear chiral symmetry, beyond nonlinear chiral symmetry, and standard forms of nonlinear realizations are considered. (auth)

5338 QUANTUM ELECTRODYNAMICS. Low, F. E. (Inst. for Advanced Study, Princeton, N. J.). pp 297-303 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, Internaonal Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

After a brief review of the experimental situation, the role of the weak interactions in providing a possible cut-off for conventional quantum electrodynamics is discussed. (auth)

5339 CROSS SECTIONS OF ELASTIC AND INELASTIC PROCESSES AT HIGH ENERGIES IN A QUANTUM FIELD THEORY. Logunov, A. A. (Inst. of High-Energy Physics, Serpukhov, USSR); Nguyen Van Hieu. pp 9-40 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).

See CONF-671087.

Experimental consequences on the analyticity and unitarity of scattering amplitudes based on principles of the local field theory and verification of microcausality principle are discussed outlining mostly the physical sides of the problem and the argument methods. (R.V.J.)

5340 FORMULATION OF SPECIAL RELATIVITY BY MEANS OF GALILEAN TRANSFORMATIONS. Gomberoff, L.; Krause, J.; Lopez, C. A. (Univ. de Chile, Santiago). Amer. J. Phys., 37: 1040-6(Oct. 1969).

Special relativity is formulated in terms of Galilean transformations. This is possible by using the principle of general covariance in the framework of special relativity. In particular the relativistic contraction of lengths and time dilation are discussed. It is further shown that classical electrodynamics also can be formulated consistently when using Galilean transformations. Finally, this result is illustrated by evaluating the field of a uniformly moving charge. (auth)

5341 A MODEL OF YUKAWA QUANTUM FIELD THEORY. Glimm, James (New York Univ., N. Y.); Jaffe, Arthur. Contract AF-49-(638)-1719. Phys. Rev. Lett.; 23: 1362-3(8 Dec 1969).

Local quantum fields are constructed in two dimensions with a scalar Yukawa interaction. The corresponding Hamiltonian has two ultraviolet-divergent renormalization constants. (auth)

Gravitation and General Relativity

Refer also to abstract 4926.

5342 PROBLEM OF THEORY OF GRAVITATIONAL FIELDS. Gottlieb, J. (Univ., Iasi). Stud. Cercet. Astron., 13: 11-18(1968). (In Rumanian).

Some problems presented by Einstein's general theory of the relativity are presented, outlining methods which help to avoid the difficulties. The questions treated included the need to supplement Einstein's equation; the general theory of relativity is considered a theory of the interaction between the gravitational field and matter, and not a theory of the gravitational field alone. The linear theory of gravitation is examined considering also the case of a uniform field. Reactions of the elementary particles may be treated only within the framework of the quantum theory. It is shown that the deformation of the elementary volume with respect to the Minkowski elementary volume is independent of the coordinates. Einstein's equations are compatible only with this condition. (TTT)

5343 THE (t/z)-TYPE PLANE WAVE SOLUTIONS OF THE FIELD EQUATIONS OF EINSTEIN'S NONSYMMETRIC UNIFIED FIELD THEORY IN BONDI SPACE-TIME. Lal, K. B.; Ali, Najaf (Gorakhpur Univ., India. M. L. K. Degree Coll., Balrampur, India). Tensor, 20: 299-302(Sept. 1969).

The equations of Einstein's nonsymmetric unified field theory are studied. The components for the (t/z)-type metric are given, and the nonsymmetric fundamental tensor corresponding to plane waves is found. The wave solutions of the other field equations are also given. It is noted that the solutions obtained can be shown to be a particular case of previous solutions. (J.F.P.)

5344 ON SOLUTIONS OF EINSTEIN'S UNIFIED FIELD EQUATIONS OF GRAVITATION AND ELECTROMAGNETISM IN A $V_2 x V_2$ SPACE-TIME. Lal, K. B.; Khare, D. C. (Univ. of Gorakhpur, India). Tensor, 20: 335-42(Sept. 1969).

The Einstein nonsymmetric unified field equations based on a nonsymmetric tensor are studied and their solutions are found. It is shown that in the case of $V_2 \times V_2$ the space-time equation shows that the electromagnetic field depends upon the gravitational potential while determining the structure of the space-time in the nonsymmetric unified field theory. (J.F.P.)

5345 TENSORIAL CONCOMITANTS AND CONSERVATION LAWS. du Plessis, J. C. (King's Coll., London). Tensor, 20: 347-60(Sept. 1969).

The algebraic structure of tensorial concomitants is analyzed, and the results are used to construct conserved complexes. A general tensorial function rather than a Lagrangian is used to generate strong conservation laws. It is found that many strong conservation laws can be accounted for in this way especially the infinite classes of Goldberg. The problem considered is: given a Riemannian space and a tensor concomitant F of the metric tensor and of its derivatives up to a given order m, to find conservation laws which result from the tensor character of F. It is also shown that each scalar density generates a covariant conservation law of the form $P^{ij}_{ij} = 0$ and a vector conservation law if $m = 2$, $K^{i}_{ij} = 0$, involving an arbitrary vector field. (J.F.P.)

5346 DIVERGENCE CONDITION FOR THE SOFT GRAVITON EMISSION AMPLITUDE. Kobsarev, I. Yu.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 30B: 488-9(24 Nov 1969).

The divergence condition for the graviton inner bremsstrahlung is used to reconstruct the emission amplitude with the account of spin dependent terms. (auth)

Scattering Theory

Refer also to abstracts 5225, 5290, and 5339.

5347 AN EQUATION INCORPORATING CROSSING SYMMETRY, REGGE ASYMPTOTIC BEHAVIOUR, AND TWO-BODY UNITARITY. Campbell, J. A.; Yaes, R. J. (Texas Univ., Austin). Aust. J. Phys.; 22: 655-62(Oct 1969).

An explicitly crossing-symmetric generalization of Kadyshevsky's quasi-potential equation is proposed. The equation has the two-body unitarity cuts in all three channels. Applied to a particular continuation of the Veneziano amplitude off the energy-momentum shell, it produces an amplitude with Regge asymptotic behavior. (auth)

5348 FAMILIES OF REGGE TRAJECTORIES. Toller, M. (CERN, Geneva). pp 151-5 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

It is shown that the factorization property and the analyticity constraints in the Regge pole hypothesis give rise to the appearance of the parity doublets and of a new quantum number M. The necessity and the classification of the families of trajectories are briefly discussed. The relation with the group-theoretical approach is considered. (auth)

5349 LIFE ON THE LIGHT CONE. (BEHAVIOUR OF REGGE TRAJECTORIES NEAR ZERO ENERGY). Domokos, G. (Central Research Inst. for Physics, Budapest). pp 157-66 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The treatment covers a description of the spin of a particle, Reggeized "particles" and the trouble with the structure of the spin algebra on the light cone, the lesson of field theory, the trajectory formula, and inclusion of internal symmetries–tribes of Regge trajectories. (auth)

5350 RELATIVISTIC S-MATRIX THEORY. Eden, R. J. (Cavendish Lab., Cambridge, Eng.). pp 87-105 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB–214(Vol.2); CONF-680629(Vol.2).

This review of relativistic S-matrix theory covers properties of scattering amplitudes, including kinematics and physical regions, analytic properties and crossing symmetry, dispersion relations, unitarity and asymptotic behavior, partial wave amplitudes, symmetries and spin properties; Theoretical Foundations; including axiomatic S-matrix theory, axiomatic quantum field theory, perturbation theory, heuristic assumptions, Mandelstam representations, and Regge theory; results and experimental tests; including effective range formulas, high energy bounds, dispersion relations, asymptotic relations between cross sections and discussion of further objectives. (auth)

5351 THE S-MATRIX. Goldberger, M. (Inst. for Advanced Study, Princeton, N. J.). pp 85-6 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB–214(Vol.2); CONF-680629(Vol.2).

The history of the S-matrix is briefly summarized by way of introducing the papers by Feshbach, Eden and Omnès. (auth)

5352 A PROGRAM FOR CALCULATING REGGE TRAJECTORIES IN POTENTIAL SCATTERING. Burke, P. G. (Queen's Univ., Belfast); Tate, C. Comput. Phys. Commun., 1: 97-105 (Oct. 1969).

A computer program Regge Trajectory is described which solves the radial Schrödinger equation and finds the positions and residues of Regge poles for a Yukawa potential and follows these poles automatically as a function of energy. Also this program can compute the S-matrix and phase shifts at a specified grid of points in the complex angular momentum plane and for a given set of energies. The program can be modified to calculate Regge trajectories for any potential which can be specified by an analytic formula. The method of solution, description of the code, and the input data are discussed. (J.F.P.)

5353 HIGH-ENERGY UNITARITY AND TWO-BODY STATE DOMINANCE. Sawada, Tetsuo (Univ. of Oregon, Eugene). Nucl. Phys.; B14: 219–34(1969).

The contribution of the multi-particle intermediate states to the unitarity condition of the two-body scattering amplitudes is computed by using the multiperipheral Regge model, and the domain is determined explicitly where two-body and quasi-two-body intermediate states completely dominate the unitarity relation when $\mathrm{Im}A_2(s,t)$ is calculated. This simplified form of the unitarity relation is applied to obtain the restrictions on the high-energy scattering amplitudes. As one of the applications, it is proved that the Regge trajectory function $\alpha(t)$ is plotted against $\sqrt{-t}$ for negative t, and in particular it excludes the linear trajectory: $\alpha(t) = \alpha(0) - \alpha'(0)(\sqrt{-t})^2$. (auth)

5354 PADE APPROXIMANTS FOR A YUKAWA POTENTIAL. Caser, S.; Piquet, C.; Vermeulen, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B14: 119–32(1969).

The method of Padé approximants is worked out numerically for the case of a Yukawa potential to find bound states and resonances. The calculation is performed to the sixth order of the perturbation series. An interesting result about the unitarity properties of non-diagonal approximants is proved. Some insight can be obtained in the way this method works in relativistic field theory, especially in connection with left-hand singularities. (auth)

5355 ON THE SIGNATURE AND PARITY OF INTERVAL TRAJECTORIES IN THE GENERALIZED VENEZIANO MODEL FOR N-PARTICLES. Hopkinson, J. F. L.; Chan, Hong-mo (CERN, Geneva). Nucl. Phys.; B14: 28–36(1969).

It is shown that in the N-particle generalization of the Veneziano amplitide the parent trajectory has definite signature, while the daughters have in general mixed signature, and that the parent and first daughter trajectories have only normal parity poles, while the other daughters suffer in general from parity doubling. (auth)

Particle Accelerators

Refer also to abstracts 4303, 5109, 5121, and 5389.

5356 (BNL–14137) PLANS FOR EXPERIMENTAL AREAS AT THE NAL 200 TO 400 GeV ACCELERATOR. Sanford, J. R. (Brookhaven National Lab., Upton, N. Y.); Elioff, T. (California Univ. [Berkeley]. Lawrence Radiation Lab.). Jun 1968. 37p. Dep. CFSTI.

Design proposals and plans for the primary target stations and secondary beam layouts for the NAL Synchrotron are outlined. (W.H.K.)

5357 (BNL–14139) AN ANALYTICAL MODEL FOR THE BETATRON PARAMETERS OF THE AGS. Herrera, J. C.; Month, M. (Brookhaven National Lab., Upton, N. Y.). 20 Oct 1969. 12p. Dep. CFSTI.

By assuming the phase function to be the sum of a linear term and harmonic components having the fundamental periodicity of the AGS, a consistent set of betatron functions with the betatron number ν as a parameter is obtained as well as a forcing function which exhibits a gradient distribution similar to the basic FOFODODO structure of the AGS. (W.H.K.)

5358 (COO–1265-70) CONTROL SYSTEM FOR 90° ANALYZING MAGNET. Bergman, Clark; Hobbie, R. K. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Nov. 1968. 105p. Dep. CFSTI.

An analyzing magnet control system for a tandem Van de Graaff accelerator is described. To set the magnetic field for a particular energy, the system first tunes the oscillator to the corresponding frequency and then adjusts the magnetic field until the NMR resonance occurs at that frequency. The resonance frequency corresponding to the desired beam energy is normally calculated by the CDC 3100 on-line computer and fed directly to the frequency control system. (W.H.K.)

5359 (JINR–E9-4751) ON THE THEORY OF THE RADIATIVE INSTABILITY OF THE RELATIVISTIC CHARGED RINGS. Bonch-Osmolovsky, A. G.; Perelstein, E. A.; Tsytovich, V. N. (Joint Inst . for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 8p. Dep. CFSTI (U. S. Sales Only).

The azimuthal radiative instability is considered for a beam of relativistic particles, rotating inside a metallic tube. Expressions for increments have been obtained. It is shown that the heat spread in the beam decreases the instability increments and leads to the instability stripping far from the chamber wall. Nonlinear effects and the characteristic time of the instability development are estimated. (auth)

5360 (JINR-P9-4737) FOCUSING OF AN ELECTRON RING IN A COLLECTIVE LINEAR ION ACCELERATOR BY A SYSTEM OF THE "SQUIRREL CAGE" TYPE. Dolbilov, G. V.; Ivanov, I. N.; Perel'shtein, E. A.; Sarantsev, V. P.; Shevtsov, V. F. (Joint Inst. for Nuclear Research, Dubna (USSR). 1969. 8p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An axial focusing of an electron ring by means of image forces has been considered for the case when the screen is a system of the "squirrel cage" type. A possibility for the practical use of this system in a collective ion accelerator is discussed. (auth)

5361 (LA–4241) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR THE PERIOD ENDING JULY 31, 1969. (Los Alamos Scientific Lab., N. Mex.). Sept. 5, 1969. Contract W-7405-eng-36. 47p. Dep. CFSTI.

Developments at the LAMPF are outlined including accelerator structures, rf power systems, accelerator control and instrumentation, accelerator physics, and experimental area. LAMPF users activities, LAMPF scheduling and facility construction, and physics research are discussed, and publications are listed. (W.H.K.)

5362 (RHEL/R–184) DESIGN PROPOSAL FOR A CONCRETE INSULATED MAGNET FOR THE EUROPEAN 300 GeV ACCELERATOR. Gresham, A. T.; Sheldon, R.; Stapleton, G. B. (Rutherford High Energy Lab., Chilton (England)). Oct 1969. 10p. Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

A bending magnet suitable for a separated function machine was designed, using concrete insulation for the coils and concrete restraints for the laminated yoke, resulting in an integral prestressed concrete structure. The magnet has the advantage of being unaffected by high energy radiation. (auth)

5363 (SLAC-Trans–103) ACCELERATING RESONATOR FOR THE VEPP-2 STORAGE RING. Veshcherevich, V. G.; Karliner, M. M.; Petrov, V. M.; Sedlyarov, I. K.; Shekhtman, I. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt for Stanford Linear Accelerator Center, Calif.), from Russian Preprint No. 272. 12p. Dep. CFSTI.

The resonator of the VEPP-2 storage ring operates in two oscillation modes: the antiphase mode (natural frequency 75 MHz, shunt resistance about 1 Mohm) and in the inphase mode (natural frequency 25 MHz, effective shunt resistance about 7.5 kohm). The operating accelerating voltage of up to 300 kV at the third-harmonic of the rotational frequency is ensured by the first mode. The second mode is used to recapture the particles from three separatrices onto one. Full account is taken in the resonator design of the required spectrum of higher natural frequencies, so that coherent synchrotron and betatron oscillations are adequately damped out. (auth)

5364 (SLAC-Trans-104) HIGH-FREQUENCY POWER SUPPLY OF THE VEPP-2 STORAGE RING. Gorniker, E. I.; Karliner, M. M.; Petrov, V. M.; Petukhov, V. V.; Shekhtman, I. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt for Stanford Linear Accelerator Center, Calif., from Russian Preprint No. 285. 12p. Dep. CFSTI.

The equipment described consists of two tuned power amplifiers, a master oscillator, and a control system. One of the amplifiers, operating at a wavelength of $\lambda_1 = 4$ m, has a rated power of 150 kW, so that it can be used to develop a voltage of up to 300 kV across the accelerating gap, which is necessary to ensure a short bunch length. The other amplifier has a rated power of 20 kW and operates at a wavelength $\lambda_2 = 12$ m. It is used to take the stored particles from three separatrices onto one. The common master oscillator and the control system ensure correct phasing of the voltages at the two frequencies. The control units stabilize the operation of the system, automate the operation of recapture, and contain feedback circuits which suppress electromechanical oscillations of the resonator. (auth)

5365 (UCRL-71706) LAWRENCE RADIATION LABORATORY ACCELERATOR SAFETY PROGRAM. Rich, Bryce L.; Kase, Kenneth R. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Oct 1969. 6p. (CONF-691101-7). Dep. CFSTI.
From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

The Lawrence Radiation Laboratory at Livermore, California, has as part of its research facilities nine major accelerators and three Van de Graaff accelerators in use or under construction. These include two 10-13 MeV LINACs used for radiography; one 4 MeV LINAC used for thermonuclear research; one 40 MeV LINAC used for both research and radiography; one 35 MeV LINAC in use and one 100 MeV LINAC under construction for physics research; one Insulating Core Transformer (ICT) neutron generator; one 90-inch cyclotron; a combination 12 MeV tandem Van de Graaff/30-inch cyclotron under construction, also for physics research; and the 3 Van de Graaffs. A brief description of the LRL accelerator facilities, examples of procedural variance, and a description of a uniform LRL safety guide for all accelerator facilities are presented. (W.H.K.)

5366 FOCUSING OF CHARGED PARTICLES IN QUADRUPOLE SPIRAL SYSTEM IN PRESENCE OF LONGITUDINAL MAGNETIC FIELD. Trotsyuk, N. I. (Ukrainian Inst. of Marine Engineers, Rovno, USSR). Ukr. Fiz. Zh., 14: 1510-14(Sept. 1969). (In Russian).

The focusing of charged particles is investigated in a combined spiral quadrupole system along the axis of which there is a longitudinal homogeneous magnetic field. It is shown that such a system can be used for sorting out the charged particles according to their velocities and specific charges. With a certain selection of the system's parameters, velocity and a specific charge of a particle such a system can give undistorted reflection of a flat object, the plane of which is perpendicular to the axis of the system. The sizes of the reflection are equal to those of the object but the reflection is turned round the system's axis. (auth)

5367 EXPERIMENTAL USE OF THE 200 GeV ACCELERATOR. Keefe, Denis (Univ. of California, Berkeley). pp 241-53 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967.
See CONF-671087.

A summary and guide is given for experimental topics on the studies in the experimental use of the 200-GeV accelerator. Brief mention is made of experimental equipment and targeting facilities, but the main emphasis is on experiments and secondary beams. The background and status of the 200-GeV accelerator, the use of the accelerator, and standard and special beams including counter, spatially separated p, $\bar{p}$, $\pi^\pm$, and $K^\pm$ beams, neutral K^0 and n, hyperon, electron and photon, neutrino and muon beams are covered. (J.F.P.)

5368 APPLICATION OF SUPERCONDUCTIVITY IN HIGH-ENERGY PHYSICS EXPERIMENTS. Glasnik, I. (Electrotechnological Inst., Bratislava). pp 665-93 of International Theoretical School on High Energy Physics for Experimentalists, Popradske Pleso, High Tatra Mountains, Czechoslovakia, 8-24 October 1967. Rez, Czech., Nuclear Research Institute of the Czechoslovak Academy of Sciences, 1967. (In Russian).
See CONF-671087.

Physical properties of superconductors, problems related to the use of hard superconductors in magnet construction for high-energy physics, and the feasibility of using superconductors in high-frequency devices in high-energy physics installations are discussed. (R.V.J.)

5369 NANOSECOND TIMING USING A PLASTIC SCINTILLATOR IN A CYCLOTRON BEAM. Warner, R. A.; Smith, G. L.; Lieder, R. M.; Draper, J. E. (Univ. of California, Davis). Nucl. Instrum. Methods; 75: 149-51(1969).

Fast plastic scintillators were used directly in 5 nA, 25 to 70 MeV alpha-particle beams to provide a direct, stable reference timing signal for experiments requiring time measurements in the ns region. (auth)

5370 METHOD AND APPARATUS FOR CHARGED PARTICLE ACCELERATION. (to Atomic Energy of Canada Ltd.). British Patent 1,168,045. Oct. 22, 1969. Priority date Sept. 11, 1967, Canada.

A method for increasing the output of a linear accelerator is described. Bunches of oppositely charged particles of the same charge-mass ratio are injected 180° out of phase with the bunches of charged particles for which the linac was designed. The bunches of particles can be separated into separate beams by steering magnets or electrostatic fields. (W.H.K.)

5371 HIGH-ENERGY (< 18 GeV) MUON TRANSPORT CALCULATIONS AND COMPARISON WITH EXPERIMENT. II. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.); Barish, J. Nucl. Instrum. Methods; 75: 344-6(1969).

Calculations of the transport of high-energy photomuons through a very thick iron shield have been carried out. The results presented differ from those given previously in that the angular distribution of the photons which produce the photomuons is included in the calculations. It is shown that the effect of this angular distribution is small and does not account for the previously reported discrepancy between calculated and experimental results. (auth)

5372 METHODS OF TARGET-THICKNESS MEASUREMENTS. Kato, S. (Tohoku Univ., Sendai). Nucl. Instrum. Methods; 75: 293-6(1969).

A combined system of various methods of target-thickness measurements is described. Each method has its disadvantages and restricted range of validity, but by applying the system as a whole, the thickness of any kind of target element can be measured with an accuracy better than ±5%. (auth)

5373 MEASUREMENT OF THE LONGITUDINAL CHARGE DISTRIBUTION IN ELECTRON BUNCHES OF A LINEAR ACCELERATOR. Chehab, R.; Brunet, P. (Ecole Normale Superieure, Orsay, France). Nucl. Instrum. Methods; 75: 254-60(1969). (In French).

To measure the charge distribution in an electron bunch an experimental method using a deflector-resonant cavity or travelling wave structure-working with the frequency of the linear accelerator was developed. Considering this apparatus as a "linear filter," some properties and limitations inherent with it are discussed. (auth)

5374 DESIGN FOR A NONINTERCEPTING PHOTON-BEAM MONITOR. Gearhart, R. A. (Stanford Univ., Calif.); Klein, P. R.; Murray, J. J.; Podolsky, W. J.; Rabin, M. S.; Sinclair, C. K. Nucl. Instrum. Methods; 75: 220-2(1969).

The design of a combination collimator-monitor used with the SLAC Compton-scattered photon beam facility is described. The beam is collimated to a half angle of 10^{-5} rad and the monitor is sensitive to changes in beam steering of 10^{-6} rad. (auth)

5375 ELECTRONIC INSTRUMENTATION FOR A NONINTERCEPTING PHOTON-BEAM MONITOR. Barna, A.; Cisneros, E. L.; Dale, C.; Johnson, A. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 75: 223-8(1969).

The paper describes the electronic instrumentation for a nonintercepting photon-beam monitor in use at the 82" bubble chamber at the Stanford Linear Accelerator Center. The position and the intensity of the beam are monitored by four shower-counters placed behind a 2-mm collimator. The bubble chamber flash-illumination and camera-advance are inhibited when the beam is not centered within 0.5 mm. (auth)

5376 USE OF A FARADAY CUP IN TARGET GAS FOR LOW ENERGY OR HEAVY CHARGED PARTICLE RECORDING. Chuang, L. S. (Chinese Univ., Hong Kong). Nucl. Instrum. Methods; 75: 171-2(1969).

A Faraday cup for charged particles was found to give consistent results when used in ^{4}He target gas, and in vacuum isolated by a Ni-foil of 1 μm thickness. (auth)

5377 GASEOUS TARGET OF ISOTOPIC BORON. Chanut, Y.; Drain, D.; Meynadier, C. (Institut d'Etudes Nucleaires, Algiers). Nucl. Instrum. Methods; 75: 74-6(1969). (In French).

A gaseous target of isotopic boron with chemical form B_2H_6 is described. The contamination of carbon, nitrogen and oxygen compounds is very weak. This target has been used with a differential pumping for the study of ^{11}B(p,p)^{11}B and ^{11}B(^{3}He,p)^{13}C reactions. (auth)

5378 A SCATTERING CHAMBER-CRYOSTAT FOR 100 MeV PROTONS USING LITHIUM DRIFTED GERMANIUM DETECTORS. Horowitz, Y. S.; Bell, R. E. (McGill Univ., Montreal). Nucl. Instrum. Methods; 75: 5-12(1969).

A compact scattering chamber has been developed for the inelastic scattering of 100 MeV protons using Ge(Li) crystals as the total absorption proton detector. The Ge(Li) detector is mounted on a LN_2 cooled copper cold finger and is directly preceded by a "window" anticoincidence plastic scintillator and brass collimator designed to limit detected events to a central region of the detector's sensitive volume. The detector platform is externally adjustable so as to insure coplanarity of the detector's symmetry axis with the proton beam axis. The chamber also provides the usual scattering facility requirements and can be mounted directly on a 25 liter Linde dewar. An overall experimental resolution of 0.38 ± 0.02 MeV (fwhm) has been achieved for 100 MeV protons. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 4991 and 5563.

5379 (KAPL-3356) DREDFUL: A SYSTEM OF PROGRAMS FOR THE REDUCTION OF NEUTRON INELASTIC SCATTERING DATA. Esch, L. J.; Moore, W. E. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 1969. Contract W-31-109-eng-52. 82p. Dep. CFSTI.

The DREDFUL System is a set of three computer programs designed for the full reduction and presentation of data accumulated from the inelastic scattering of neutrons. DREDFUL accepts data in the form of neutron counts vs time-of-flight, taken simultaneously at as many as six scattering angles. It computes the double-differential cross section with respect to solid angle, the differential cross section with respect to solid angle, and the scattering law as a function of momentum and energy transfers. ADNPLOT accepts as input the cross section vs energy output from DREDFUL and, on option, the results of theoretical computations of cross section vs energy. This program averages the results of several independent experimental runs made under similar conditions; it plots the results and corresponding theoretical curves in a form directly suitable for publication. SLAWFIT accepts as input the scattering law vs energy transfer from DREDFUL. SLAWFIT combines data from various runs at the same incident energy. It then averages the data for all values of the energy transfer in the vicinity of each of 30 preselected integer or half-integer values for each of the different incident energy runs on a given sample. It plots scattering law vs momentum transfer, one curve for each of the preselected values of the energy transfer, and up to three different sets of theoretical calculations. Finally, an option, SLAWFIT plots the scattering law times the square of the energy transfer divided by the momentum transfer. The three programs are written in standard FORTRAN IV language. (auth)

5380 (WAPD-TM-810) SUMOR (MO271): A FORTRAN-IV PROGRAM FOR THE CDC-6600 FOR NEUTRON RESONANCE CROSS SECTIONS INCLUDING LEVEL-LEVEL INTERFERENCE AND EXACT DOPPLER BROADENING. Harris, D. R.; Noll, C. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1969. Contract AT-11-1-GEN-14. 29p. Dep. CFSTI.

SUMOR, a FORTRAN-IV program previously available on the Philco-2000, is now available on the CDC-6600 with additional capabilities. SUMOR calculates S-wave neutron scattering and radiative capture cross sections using Reich and Moore resonance formulae, Feshbach, Porter and Weisskopf resonance formulae, and sums of single level formulae. Cross sections are Doppler broadened exactly for target nuclei in Maxwellian motion. Calculated cross sections or calculated cross sections multiplied by reciprocal neutron energy are integrated between arbitrary energy limits. (auth)

5381 INELASTIC NEUTRON SCATTERING FROM LIQUID HELIUM IN ITS GROUND STATE. Fernandez, J. F. (Univ. of South Carolina, Columbia); Gersch, H. A. Phys. Lett., 30A: 261-2(Oct. 20, 1969).

Observed periodic fluctuations in the energy width as a function of momentum transfer of neutrons scattered off ground state helium liquid are explained as due to short range hard-core interactions between helium atoms. (auth)

5382 THE REACTION $^{51}V(p,n)^{51}Cr$ AS A SOURCE OF MONOENERGETIC NEUTRONS. Deconninck, G. (Univ., Louvain, Belgium. Facultes Univ., Namur, Belgium); Royen, J. Nucl. Instrum. Methods; 75: 266-70(1969). (In French).

The reaction $^{51}V(p,n)^{51}Cr$ has been studied between 2.2 and 4 MeV in order to determine the possibility of using this reaction as a source of monoenergetic neutrons; angular distributions have been measured and found to be quasi-isotropic. It is shown that for some applications this source is better than the conventional ones because of the slow variation of intensity and energy with angle and also because of the ease with which the targets can be made and utilized. Simple empirical relations between the energy of the protons and the absolute cross sections are deduced. Cross sections and coefficients of Legendre polynomial expansions have been tabulated. (auth)

5383 ORIENTED GRAPHITE AS A NEUTRON MONOCHROMATOR. Riste, T.; Otnes, K. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Instrum. Methods; 75: 197-202(1969).

A number of samples of oriented UCAR graphite of various thicknesses and mosaic widths have been investigated for reflectivity of thermal neutrons. The observed values agree rather well with those calculated on the assumption of ideally imperfect samples. The peak reflectivity and integrated reflectivity were found to be superior to other monochromators tested by a factor of about 2–10. For 4 Å neutrons peak reflectivities above 0.9 can easily be attained. An important feature is the absence of double Bragg scattering in graphite, leading to a considerable reduction of the intensity of extraneous neutrons in the primary beam. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstract 4468.

5384 ANALYSIS OF D(p,n)2p REACTION AT 45.5 MeV WITH THE FADDEEV FORMALISM. Oryu, Shinsho (Science Univ. of Tokyo); Shioyama, Shozo; Takahashi, Yasutaro. Progr. Theor. Phys. (Kyoto), 42: 425-8(Aug. 1969).

The D(p,n)2p reaction at 45.5 MeV was studied using the Faddeev method. The claculations were performed on the basis of overlapping amplitudes, where n-p and p-p interactions are inserted on an equal footing. The results are compared with experiment. (J.W.R.)

5385 DUAL CORE MODEL FOR ^3He. Narayana, K. L. (Shivaji Univ., Kolhapur, India). Curr. Sci. (India), 38: 487-8 (Oct. 20, 1969).

An attempt was made to estimate the ground-state energy of ^3He by the dual core model. The nucleus is treated as a resonating structure of two protons with the single neutron forming a deuteron with either of the protons. The neutron moves in an overall field plus the harmonic potential due to the oscillating core. These potentials are fitted to the experimental binding energy. (J.W.R.)

5386 A PROPOSED METHOD FOR THE ABSOLUTE MEASUREMENT OF NEUTRON POLARISATION. White, R. E.; Chisholm, A.; Garrett, R. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods; 75: 333-4(1969).

A method is proposed by which absolute measurements of neutron polarization could be made at some energies in the low and medium energy range. The application of this technique to n-helium polarization studies is considered. (auth)

5387 A NEW IMPULSE APPROXIMATION IN THE $\alpha(d,np)\alpha$ REACTION. Nakamura, Hiroshi (Aoyama Gakuin Univ., Tokyo). Nucl. Phys., A137: 51-64(1969).

An improved impulse approximation in the $\alpha(d,np)\alpha$ reaction is introduced. The effects of the final state interaction of the spectator nucleon and the initial state interaction of the incoming deuteron are partly taken into account in the calculation of differential cross sections. The results give a rather good fit to the experimental analysis. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 4468, 4877, and 5442.

5388 (CEA-R-3808) CROSS SECTIONS FOR THE PRODUCTION OF GAMMA RADIATION BY 5 MeV, 6.6 MeV AND 8.7 MeV NEUTRONS ON CARBON, ALUMINUM, IRON, AND BISMUTH. Bertin, Andre; Bertrand, Francoise; Clayeux, Genevieve; Gautier, Michele; Nierat, Georges (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). July 1969. 49p. (In French). Dep. CFSTI (U. S. Sales Only).

A study was made of the gamma spectra of C, Al, Fe and Bi using a spectrometer placed at 90°. The different samples are bombarded by neutrons at energies of 5 MeV, 6.6 MeV, and 8.7 MeV. The cross sections for gamma production were calculated for levels which are particularly well resolved and for which the statistical error is less than 2 per cent. The gamma radiation observed has an energy of 4.43 MeV for ^{12}C; 0.842 MeV, 1.013 MeV, 1.72 MeV, and 2.21 MeV (2.976 MeV–3 MeV) for ^{27}Al, 0.850 MeV, 1.03 MeV, 1.24 MeV and 1.81 MeV (2.09 MeV–2.11 MeV) and 2.6 MeV for ^{56}Fe, and 0.90 MeV and 1.605 MeV for ^{209}Bi. The values in mb/sr at 90° are given to ±22 per cent up to $E\gamma = 2$ MeV and ±26 per cent above this value. (auth)

5389 (COO-1265-83) ANNUAL REPORT [ON NUCLEAR PHYSICS], 1969. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Aug. 1969. Contract AT(11-1)-1265. 159p. Dep. CFSTI.

ALUMINUM-27—deuteron reactions (d,He-3) at 19 MeV, helium-3 spectra from, (E)
BERYLLIUM-6—energy levels from lithium-6 (He-3,t) reactions
CHROMIUM-48—energy levels from chromium-50 (p,t) reactions, spin-parity assignments for, (E)
CHROMIUM-50—proton reactions (p,t) at 40 MeV, triton momentum spectra and angular distributions for, (E)
COBALT-59—proton elastic scattering at 9.8 MeV, cross section and polarization for, (E)
FLUORINE-18—energy levels from neon-20 (p,He-3) reactions, spin-parity assignments for, (E)
ION SOURCES—development of negative, for tandem Van de Graaff accelerator
LITHIUM-6—helium-3 reactions (He-3,t) at 28 MeV, triton spectra from, (E)
MAGNESIUM-26—energy levels from aluminum-27 (d,He-3) reactions, spin-parity assignments for, (E)
  —deuteron reactions (d,He-3) at 20 and 34 MeV, analysis using modified DWBA, (E/T)
NEON-18—energy levels from neon-20 (p,t) reactions, spin-parity assignments for, (E)
NEON-19—energy levels from fluorine-19 (He-3,t) reactions, spin-parity assignments for, (E)
NEON-20—energy levels from neon-22 (p,t) reactions, spin-parity assignments for, (E)
NICKEL-58—helium-3 reactions (He-3,t) at 24.6 MeV, angular distributions for, (E)
NICKEL-60—helium-3 reactions (He-3,t) at 24.6 MeV, angular distributions for, (E)
NITROGEN-14—helium-3 reactions (He-3,d) and (He-3,p) at 24 MeV, deuteron and proton spectra from, (E)
OXYGEN-16—energy levels from nitrogen-14 (He-3,p) reactions, (E)
OXYGEN-17—proton reactions (p,He-3) and (p,t) at 40 MeV, relative differential cross sections for, (E)
PALLADIUM-108—proton reactions (p,t) at 19 MeV, angular distributions for, (E)
SAMARIUM-152—proton reactions (p,t) at 19 MeV, angular distributions for, (E)
SCANDIUM-44—energy levels from scandium-45 (d,t) reactions, spectroscopic factors for, (E)
SCANDIUM-45—deuteron reactions (d,t) at 19.5 MeV, triton spectra and angular distributions for, (E)
SCANDIUM-46—energy levels from titanium-48 (d,α) reactions, spin-parity assignments for, (E)
SCANDIUM-48—energy levels from titanium-50 (d,α) reactions, spin-parity assignments for, (E)
SILICON-29—helium-3 reactions (He-3,d) at 25 MeV, deuteron spectra from, (E)
  —deuteron reactions (d,p) at 20 MeV, proton spectra from, (E)
SILICON-30—energy levels from silicon-29 (d,p) reactions, spin-parity assignments for, (E)
SILVER-109—proton reactions (p,t) at 19 MeV, angular distributions for, (E)
SPECTROMETERS—operation of Enge split-pole magnetic
TITANIUM-44—energy levels from titanium-46 (p,t) reactions, spin-parity assignments for, (E)
TITANIUM-46—proton reactions (p,t) at 40 MeV, triton momentum spectra and angular distributions for, (E)
TITANIUM-48—alpha reactions (α,xn) at 25 MeV, gamma spectra from, (E)
TITANIUM-49—deuteron reactions (d,He-3) at 19.5 MeV, helium-3 spectra and angular distributions for, (E)
TITANIUM-50—deuteron reactions (d,α) at 19 MeV, alpha spectra from, (E)
VAN DE GRAAFF ACCELERATORS—operation of University of Minnesota tandem
VANADIUM-50—energy levels from vanadium-51 (d,t) reactions, spectroscopic factors for, (E)
VANADIUM-51—deuteron reactions (d,t) at 19.5 MeV, triton spectra from, (E)
ZIRCONIUM-90—proton elastic scattering at 9.8 MeV, cross section and polarization for, (E)
YTTERBIUM-174—proton reactions (p,t) at 19 MeV, angular distributions for, (E)
  —energy levels from ytterbium-176 (p,t) reactions, spin-parity assignments for, (E)
YTTERBIUM-176—proton reactions (p,t) at 19 MeV, angular distributions for, (E) (J.W.R.)

5390 (JINR-P4-4742) DECAY OF THE GIANT RESONANCE STATES IN ^{16}O NUCLEUS. Vartanyan, V. A.; Zhusupov, M. A.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Within the particle-hole approximation the decay of the giant resonance states in ^{16}O nucleus to the levels of positive parity in ^{15}N nucleus was calculated. It is shown that divergence of the predictions with the experimental data is rather considerable. Possible causes of this divergence are discussed. (auth)

5391 DIRECT PHOTODISINTEGRATION OF ^{13}C BELOW 17 MeV: REACTION $^{13}C(\gamma,n)^{12}C$. Aurdal, Terje (Univ., Tuebingen, Ger.). Z. Naturforsch., 24a: 1361-4(Sept. 1969).

A nuclear model where the single-particle states of the valence neutron are vector coupled to the ground (0^+) and first excited (2^+) ^{12}C-core states, is considered. The model is applied to calculate total photodisintegration cross sections of the reaction $^{13}C(\gamma,n)^{12}C$ for energies below the Giant dipole resonance. The radial wavefunctions in initial as well as final states are of the Saxon-Woods type. (auth)

5392 COMPARISON OF VARIOUS APPROXIMATIONS FOR THE GROUND STATE OF ^{16}O. Ellis, Paul J.; Zamich, Larry (Rutgers–The State Univ., New Brunswick, N. J.). Ann. Phys. (N. Y.), 55: 61-76(Oct. 15, 1969).

The amount and nature of 2 particle-2 hole correlations in the ground state of ^{16}O was investigated using various approximations. First $2\hbar\omega$ excitations were considered with the particles in the 2s–1d shell and the holes in the 1p shell. Matrix diagonalization with spurious states removed, resulted in 22% 2p–2h ground state correlations and a depression of the ground state energy of 7.9 MeV; if spurious states were incorrectly included, then both numbers were nearly doubled. The corresponding numbers for the RPA were 43% and 8.2 MeV using the quasi-boson approximation. This approximation is suggested to be inaccurate. Ordinary perturbation theory gave results remarkably close to matrix diagonalization. The corresponding wave functions had an overlap of .993. The correlations were spread over very many j-j coupling states but could be localized to relatively few states in the L–S representation. Perturbation theory was used in a larger space where the 2 particle-2 hole energy could be greater than $2\hbar\omega$. This led to 32% 2p–2h correlations and the ground state depression was 24 MeV. The correlations with $2\hbar\omega$ and $4\hbar\omega$ energy were comparable. A dispersion method gave less correlation but qualitatively similar results. In the smaller configuration space the first excited 0^+ state was at 24 MeV excitation energy relative to the ground state, but a more realistic estimate is probably about 14 MeV. This state looked slightly simpler in j-j rather than L–S coupling. (auth)

5393 A STUDY OF THE RADIATIVE CAPTURE OF ^{4}He BY ^{12}C BELOW 4 MeV. Jaszczak, Ronald Jack. Gainesville, Fla., Univ. of Florida, 1968. 116p.

Thesis.

Radiative capture of ^{4}He by ^{12}C was studied via the $^{12}C(^4He,\gamma)^{16}O$ reaction at incident particle energies from about 4 MeV down to 1.9 MeV, using a Van de Graaff accelerator. Targets were fabricated by synthesizing acetylene from 99.94 per cent enriched ^{12}C and cracking the carbon from the gas onto 10 mil tantalum backings with a high-frequency discharge. Target thickness ranged from 25 to 55 keV for 3.6 MeV ^{4}He particles. Beam currents were 1 to 3 microamperes, and special precautions were taken to retard natural carbon buildup on targets during experimental runs. Capture gamma rays were detected (at 55° with respect to the beam axis) with a 12.7 cm × 12.7 cm NaI(Tl) scintillator; some spectra were studied in detail with a 20.1 cm^3 Ge(Li) detector. Capture cross sections were determined at twelve points between 3.37 MeV and 1.9 MeV; the measured values range from a high of 35 ± 6.1 nanobarns at 3.24 MeV down to 0.3 ± 0.1 nanobarns at 1.9 MeV. These results indicate that interference between the 1^- states at 7.12 MeV and 9.59 MeV in ^{16}O (as calculated by Tombrello) is probably constructive and that the reduced alpha particle width lies somewhere between 0.1 and 0.3. The resultant radiative width for the transition $O^+ \xrightarrow{P} 1^-$ (9.59 MeV) $\xrightarrow{E1} O^+$ is found to be 0.021 ± 0.004 eV, and the cross section factor S_0 at 10^8 °K has the value $(6.5 \pm 3.2) \times 10^2$ barns. The 9.85-MeV level in ^{16}O was examined with the Ge(Li) detector. A cascade through the 6.92-MeV level was observed: the branching ratios of the cascade and ground state transitions were determined to be 17 per cent and 83 per cent, respectively, and radiative widths were found to be 0.0011 ± 0.0002 eV (cascade) and 0.0050 ± 0.0007 eV (ground state). (Diss. Abstr.)

5394 PHOTODISINTEGRATION OF ^{7}Li AND ^{9}Be. Garfagnini, R.; Piragino, G.; Zanini, A. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim., 63B: 670-81(Oct. 11, 1969).

The energy distribution and polarization of photoneutrons at 90° from ^{7}Li and ^{9}Be were measured. The targets were irradiated with the γ-ray beam ($E\gamma_{max}$= 85 MeV) of the Turin synchrotron. The photoneutrons were detected with a diffusion cloud chamber filled with helium. In the case of ^{7}Li there is no indication of polarization, but for the ^{9}Be there is an indication of negative polarization for the photoneutrons emitted with an energy lower than 4 MeV. The comparison between the results and the spectra measured by other authors, with lower-energy γ-ray beams, shows that the photoneutrons emitted, for γ-ray energies between 20 and 85 MeV, fall mostly in the low-energy region of the spectra. The ratio between the number of photoneutrons from ^{7}Li at 90° and that at 135° is (1.07 ± 0.04) for $0.8 \leq E_n \leq 12$ MeV while for ^{9}Be this ratio is 2.5 for $0.8 \leq E_n \leq 5$ MeV and rises for higher photoneutron energies. (auth)

5395 ELECTROEXCITATION OF PARTICLE-HOLE STATES IN ^{16}O. Sick, I.; Hughes, E. B.; Donnelly, T. W.; Walecka, J. D.; Walker, G. E. (Stanford Univ., Calif.). Phys. Rev. Lett. 23: 1117-21(Nov. 10, 1969).

Experimental data and theoretical results for electroexcitation of T = 1 particle-hole states in ^{16}O are presented. (auth)

5396 INELASTIC PROTON SCATTERING AND ONE-PARTICLE–ONE-HOLE EXCITATIONS IN LIGHT NUCLEI. Reif, R. (Central Inst. of Nuclear Research, Rossendorf, Ger.); Hoehn, J. Nucl. Phys., A137: 65-79(1969).

The inelastic scattering of 17.5-MeV protons from ten normal-parity states in ^{16}O, ^{28}Si, and ^{32}S was analyzed in the DWBA treatment. In a microscopic description, the form factors were calculated with nuclear wave functions of the 1p1h model and a spin-independent effective interaction with a Gaussian shape and a range of 1.7 fm. The strength of the effective interaction derived from normalizing the computed curves to the experimental differential cross section varies between 50 MeV and 80 MeV. The measured relative cross sections for the excitation of different levels in a nucleus are reproduced within a factor of two. For strongly excited 2_1^+ and 3_1^- states and for the second 2^+ state in ^{32}S, the general tendency in the shape of the angular distribution is given by the calculations. The angular distribution in the scattering from other (weakly excited) levels and the asymmetry in the inelastic scattering of polarized particles from collective states are not described correctly. (auth)

5397 ISOSPIN-DEPENDENT MICROSCOPIC INTERACTION. Clough, A. S. (Queen Mary Coll., London); Batty, C. J.; Bonner, B. E.; Tschalaer, C.; Williams, L. E.; Friedman, E. Nucl. Phys., A137: 222-8(1969).

Measurements have been made of the ratio of the excitation cross sections of the ground and first excited state of ^{7}Be in the ^{7}Li(p,n)^{7}Be reaction at 30 and 50 MeV. The reactions were analyzed in terms of an isospin-dependent microscopic interaction and compared to a similar analysis of the ^{6}Li(p,n)^{6}Be reaction. It is found that while the spin-dependent term is constant from 30 to 50 MeV projectile energy the spin-independent term decreases by a factor of between 2 and 3 over this energy range. (auth)

5398 EVIDENCE FOR THE FIRST FORBIDDEN β DECAY ^{16}N(β^-)^{16}O(2^+,9.85 MeV). Haettig, H.; Huenchen, K.; Roth, P.; Waeffler, H. (Max-Planck-Inst. for Chemistry, Mainz). Nucl. Phys., A137: 144-56(1969).

The sequential decay ^{16}N(β^-)^{16}O(α)^{12}C from a gaseous source of ^{16}N was investigated by analyzing the energy spectrum of 34×10^6 alpha particles. A group of $(1.84 \pm 0.33) \times 10^4$ alphas with an energy of 2017 ± 10 keV could be identified. These alphas are attributed to the decay from the 2^+, 9.85 MeV state in ^{16}O. For the ^{16}N beta-decay branch leading to this state, the value log ft = 8.8 ± 0.1 was deduced, which corresponds to a branching ratio of $(6.5 \pm 2.0) \times 10^{-9}$. Parity-forbidden alpha decay from the ^{16}O(2^-, 8.87 MeV) state was not observed. The events which could be attributed to such a decay form a smaller fraction than 4×10^{-3}% of the total number of 6×10^7 alphas obtained from several measurements. This corresponds to a width $\Gamma_\alpha \leqq 0.94 \times 10^{-10}$ eV for this decay. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 4468, 5382, 5388, 5389, 5396, and 5439.

5399 (CEA-R-3602) STUDY OF SOME PROPERTIES OF BOUND LEVELS AND VIRTUAL LEVELS EXCITED WITH RESONANCE NEUTRONS. Alves, Rex Nazare (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 402p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., France.

Many neutron resonance parameters of some nuclei with a spin value $J = 3/2$(^{35}Cl, ^{37}Cl, ^{63}Cu, ^{65}Cu, ^{197}Au) are determined to find the strength function S_0 with accuracy. For those nuclei, the S_0 value seems not to depend on the spin value J = 1 or 2 but may depend on neutron energy for ^{197}Au. Total radiative width variation against mass number A and spacing distributions between resonances (for ^{197}Au) are studied and discussed. Analytical methods for neutron capture experiments are described in detail and level schemes of Cl, Mn, Fe, Co, Cu, Tm, Hg are presented along with spin values. Intensities of E_1 and M_1 transitions with direct capture and interference effects are discussed in view of experimental results. (auth)

5400 (ORNL-4456) TABULATED CROSS SECTIONS FOR HYDROGEN AND HELIUM PARTICLES PRODUCED BY 61-MeV PROTONS ON ^{56}Fe. Bertrand, F. E.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 47p. Dep. CFSTI.

Tabulated differential cross sections are presented for the production of protons, deuterons, tritons, helium-3, and alpha particles from ^{56}Fe bombarded by approximately 61-MeV protons. Continuum cross sections are listed at 10 angles from 20 deg through 160 deg. Angular distributions are given for excitation of states at 0-, 0.85-, 2.66-, 3.11-, 4.55-, 5.26-, and 6.79-MeV in ^{56}Fe; 0-, 0.41-, 0.93-, 1.92-, 2.99-, 4.97-, and 7.86-MeV in ^{55}Fe; and the ground state in ^{54}Fe. (auth)

5401 (UCRL-18958) MEASUREMENT OF THE MAGNETIC MOMENTS OF THE MICROSECOND-ISOMERS IN ^{73}As AND ^{206}Pb. Quitmann, D.; Jaklevic, J. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1969. Contract W-7405-eng-48. 29p. Dep. CFSTI.

The isomeric state of ^{73}As (426 keV, 5.8 μsec) was produced and aligned by the reaction ^{71}Ga(α,2n) in a liquid metal target. The anisotropies of the depopulating γ-rays were measured vs. the dc magnetic field applied perpendicular to the beam-detector plane. From the attenuation and rotation, $g = +1.03 \pm 0.10$ was obtained. Limits of $\delta^2 < 10^{-2}$ can be set to the multipole admixtures in both γ-transitions. The same technique was applied to the 123 μsec isomer of ^{206}Pb (2200 keV) produced by ^{204}Hg(α,2n). After deriving a limit for the relaxation time, $g = -(0.035 \pm 0.020)$ was obtained; $|Q| \lesssim 0.2$ barn was estimated. (auth)

5402 (UCRL-Trans-10392) GAMMA RAY EXCITATION OF NUCLEAR ISOMERS. Abrams, I. A.; Pelekis, L. L. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 19-27(1968). 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 32703.

5403 DECAY SCHEME OF ^{79}As. Barros Leite, C. V. (Instituto de Fisica, Rio de Janeiro); do Amaral, L. C. M.; Jeronymo, J. M. F.; de Pinho, A. G.; de Barros, S.; Maurenzig, P. R. Z. Naturforsch., 24a: 1401-5(Sept. 1969).

The γ-transitions in ^{79}Se following the decay of ^{79}As were investigated with a Ge(Li) detector. Six previously unreported γ-transitions were observed and energy and intensity measurements on eleven γ-rays are reported. A new decay scheme is proposed which incorporates all the observed γ-rays. Results concerning the decay schemes of some isotopes of selenium (81 and 73) are also presented. (auth)

5404 RESONANCE SCATTERING OF γ RAYS FROM NEUTRON CAPTURE BY NUCLEI. Begzhanov, R. B.; Akhrarov, S. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 43-9(1969). (In Russian).

Studies were made of nuclear resonance scattering of γ rays from thermal neutron capture in titanium with the energy of 6.41 MeV on ^{139}La nuclei. The decay scheme of ^{139}La is given and the experimental data for all cases of resonances with Ti(n,γ) source are tabulated. The partial width at 6.41 MeV (1^-) for ^{98}Mo and 6.41 MeV ($7/2^-$) for ^{139}La were determined by the authors. The magnitudes for transitions with 6.07 MeV ($1/2^+$) of ^{65}Cu and 7.15 MeV ($9/2^+$) for ^{209}Bi were found to be in good agreement with the published data. (R.V.J.)

5405 OPTICAL-MODEL ANALYSIS OF ALPHA-PARTICLE SCATTERING FROM ^{24}Mg. Singh, P. P.; Malmin, R. E.; High, M.; Devins, D. W. (Indiana Univ., Bloomington). Phys. Rev. Lett. 23: 1124-7(Nov. 10, 1969).

Optical-model analysis of elastic-scattering data taken at 40 MeV produces the familiar potential ambiguities, but at 80 MeV a single set is obtained. The parameters V, W, r_0, and a are found to be highly correlated and hence cannot be uniquely determined. The functions which are determined most uniquely are the rms radius of the real and imaginary potential and the products Vr_{0R}^4 and Wr_{0I}^4. (auth)

5406 INVESTIGATION OF HIGHLY EXCITED LEVELS OF NUCLEI WITH THE AID OF NEUTRON-CAPTURE GAMMA RAYS. Begzhanov, R. B.; Akhrarov, S. M. (Nuclear Physics Inst., Tashkent). JETP Lett. (USSR) (Engl. Transl.), 10: 26-8(July 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 39-41(July 5, 1969).

The resonant scattering of monochromatic neutron-capture γ rays was used to study the excited levels of several nuclei. The average resonance scattering cross sections were calculated for ^{64}Zr, ^{63,65}Ca, ^{96}Mo, ^{117}Sn, ^{134}La, and ^{209}Bi assuming a dipole angular distribution. The radiative widths and level spacings for these nuclei were determined. (J.W.R.)

5407 GAMMA–GAMMA ANGULAR CORRELATION MEASUREMENTS FROM ^{89}Y(n,γ)^{90}Y. Chintalapudi, S. N.; Sastry, D. L.; Jnanananda, S. (Andhra Univ., Waltair, India). Nuovo Cim., 63B: 447-57(Oct. 11, 1969).

Directional-correlation measurements for the transition 6.849 MeV → 0.7767 MeV → 0.0 MeV, involving the gamma-ray cascade 6.072 MeV → 0.7767 MeV from the ^{89}Y(n,γ)^{90}Y reaction were carried out employing thermal neutrons from the CIRUS reactor. The final value of the A_{22} coefficient after applying various corrections was obtained to be $A_{22} = -0.139 \pm 0.005$, while the A_{44} coefficient was zero within experimental errors. The present angular-correlation measurement is consistent with a spin assignment of 2^+ to the 0.7767 MeV state of the transition in ^{90}Y and also is in accordance with the shell-model picture. The results also suggest that the population of the neutron state in ^{90}Y is largely with unit spin and negative parity. (auth)

5408 THE ENERGY LEVEL STRUCTURE OF ^{45}Sc FROM THE (n,n′γ) REACTION. Rogers, V. C.; Beghian, L. E.; Clikeman, F. M. (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., A137: 85-96(1969).

The level structure of ^{45}Sc was examined by studying the spectra and excitation functions of gamma rays from the (n,n′γ) reaction for primary neutrons between the energies of 0.45 and 1.79 MeV. A time gated Ge(Li) spectrometer was used to detect the gamma rays. Spin and parity assignments consistent with the present experiment are made for levels from which gamma rays were observed. (auth)

5409 STUDY OF DECAY SCHEMES OF ^{58}Ni LEVELS. Beuzit, P.; Delaunay, J.; Fouan, J. P.; Ronsin, H. (CEN, Saclay, France). Nucl. Phys., A137: 97-114(1969).

Particle-gamma-ray coincidences from the ^{58}Ni(p,p′γ) reaction at 12 MeV were measured using a multi-parameter analyzing system. The coincident gamma rays were detected both with a NaI crystal and Ge(Li) detector. The major decay modes of the levels up to 8.11 MeV excitation energy were determined and some of their gamma branching ratios measured. (auth)

5410 THE QUASI-ELASTIC KNOCKOUT REACTION ^{28}Si(α,2α)^{24}Mg. Plieninger, R. D.; Eichelberger, W.; Velten, E. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., A137: 20-32(1969).

The α-cluster knockout reaction ^{28}Si(α,2α)^{24}Mg is investigated at an incident energy of 104 MeV. In a coplanar, symmetric geometry the energy distribution spectra of the coincident α-particles are measured at seven pairs of angles between 28°, 28°, and 41.5°, 41.5° (quasi-elastic angles). It is shown that besides the ground state of the recoil nucleus ^{24}Mg also the lowest excited states are found. There are, therefore, different α-cluster parent states that contribute to the wave function of ^{28}Si. The most probable configuration that is found is the coupling of a ^{24}Mg core in the excited level with $l = 4$ ($E_{exc} = 4.12$ MeV) with a probability of about 10%. (auth)

5411 DECAY SCHEME OF 17.7 min ^{88}Rb. Hess, R.; Roehmer, F. C.; Gassmann, F.; Von Ledebur, Th. (Federal Inst. of Tech., Zurich). Nucl. Phys., A137: 157-66(1969).

The decay ^{88}Rb → ^{88}Sr was re-investigated. By use of a Ge(Li) detector, the accuracy in determining the energy and intensity of gamma rays was improved, and two new transitions of 1781 ± 4 and 4740 ± 4 keV were found. Measurements of gamma-gamma directional correlation with a 7.6 cm × 7.6 cm + 5.1 cm × 5.1 cm NaI spectrometer led to spin assignments of 2^- and $(3)^-$ for the 4515 and 4850 keV levels, respectively. A revised decay scheme is presented. (auth)

5412 EFFECTS OF α PARTICLE CORRELATIONS IN ELASTIC α SCATTERING. Gaul, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Luedecke, H.; Santo, R.; Schmeing, H.; Stock, R. Nucl. Phys., A137: 177-92(1969).

Elastic α-scattering angular distributions from ^{36,40}Ar, ^{40,42,44,48}Ca and ^{41}K were measured at several energies between 18 and 29 MeV. The data show an anomalous backward rise in the angular distributions of the N = Z nuclei ^{36}Ar and ^{40}Ca as compared to ^{40}Ar and ^{44}Ca. This backward angle enhancement and its irregular energy dependence are interpreted as due to the interaction of the incident α-particles with α-particle clusters within the N = Z nuclei. Excess neutrons destroy the correlation effects. Consequences for other reactions involving α-particles are discussed. (auth)

5413 DECAY SCHEME OF ^{87}Kr. Onega, Ronald J. (Virginia Polytechnic Inst., Blacksburg); Carpenter, William B. Nucl. Phys., A137: 211-21(1969).

Standard methods of gamma- and beta-ray spectroscopy were used to investigate the decay scheme of ^{87}Kr. Natural krypton gas was irradiated to produce ^{87}Kr. A new decay scheme is proposed with energy levels at 0.40, 0.85, 1.57, 1.75, 2.42, 2.97, and 3.30 MeV. The β-ray disintegration energy of 3.85 ± 0.04 MeV from ^{87}Kr to ^{87}Rb was obtained. Angular correlation measurements between 2.57 and 0.40 MeV γ-rays indicated a possible spin-parity assignment of the 2.97 MeV level to be $\frac{9}{2}^+$. The ground state spin and parity of ^{87}Kr was inferred to be $\frac{7}{2}^+$ or $\frac{5}{2}^+$ on the basis of log ft values. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 5388, 5389, 5399, 5401, 5402, 5404, 5406, 5407, and 5436.

5414 (AE–374) GAMMA RADIATION FROM FISSION FRAGMENTS. Higbie, J. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Oct 1969. 21p. Dep. CFSTI (U. S. Sales Only).

The gamma radiation from the fragments of the thermal neutron fission of ^{235}U was investigated. The preliminary data are presented. Suggestions for further lines of research and some possible interpretations of the data are given. The data have direct bearing on the fission process and the mode of fragment de-excitation. The parameters measured were the radiation decay curve for the time interval $(1 - 7) \times 10^{-10}$ sec after fission, the photon yield, the total gamma-ray energy yield, and the average photon energy. The last three quantities were measured as a function of the fragment mass. (Sweden)

5415 (CISE-R–171) THE ^{140}Ba YIELDS FOR THERMAL AND FAST FISSION IN ^{235}U AND ^{238}U. Topical Report No. 11. Accinni, F.; Ciuffolotti, L. (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct. 1965. Contract 006-64-4-NTRI. 25p. Dep. CFSTI (U. S. Sales Only).

The absolute and relative yields of ^{140}Ba were measured in thermal and fast fission of ^{235}U and ^{238}U respectively, in order to obtain a more reliable value for the fast fission yield than that available at present. By means of direct γ-ray spectrometry of the induced activity of the Ba-La fission chain, yields values were deduced with a good degree of accuracy. (auth)

5416 (JINR-P6-4591) INVESTIGATION OF THE PROPERTIES OF THE NEUTRON-DEFICIENT CESIUM NUCLEI. II. THE ISOMER ^{122m_1}Cs($T_{1/2}$ = 0.35 sec.). Neubert, W.; Droste, Ch.; Morek, T.; Chojnacki, S.; Alexander, K.; Wilhelmi, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The previously reported isomeric state in ^{122}Cs produced via the reactions ^{113}In(^{12}C,3n)^{122}Cs and ^{109}Ag(^{16}O,5n)^{122}Cs was reinvestigated. The isomeric level decays with a half-life of $T_{1/2}$ = 0.35 ± 0.07 sec. From conversion electron measurements it follows that the 81.5-keV transition has the multipolarity E2 or M2 + 10% E3. Furthermore, a strong electron line corresponding to a 47-keV transition was found. The multipolarity of this transition is probably E3 or M2 + E3. (auth)

5417 (RLO–1388-102) ISOMER IN ^{174}Hf. Ejiri, H.; Ferguson, S. M.; Heffner, R. H.; Wieman, H. (Washington Univ., Seattle. Dept. of Physics). [1968]. 9p. Dep. CFSTI.

A positive parity isomer in ^{174}Hf was investigated using a Ge(Li) detector. The γ spectra following the ^{174}Yb(α,4nγ) and ^{173}Yb(α,3nγ) reactions were measured. Two strong γ rays of 0.940 and 1.251 were observed in addition to the ground-state rotational transitions. Lifetime measurements were made following the ^{175}Lu(p,2nγ) reaction. A half-life of 2.1 ± 0.2 μsec was determined for the 1.549 MeV isomer. (J.W.R.)

5418 DECAY OF ^{179}W^{gm}. Birattari, C. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan); Strini, G.; Tagliaferri, G.; Bertolini, G. Nuovo Cim., Lett., 2: 473-6(Oct. 1, 1969).

The decay of ^{179}W was studied using Ge(Li) detectors. Both ground and isomeric states of ^{179}W were produced through the ^{181}Ta(p,3n) reaction. The gamma spectrum up to 300 keV was measured and several previously unreported peaks were found. (J.W.R.)

5419 DECAY SCHEME OF ^{117m}Cd. Moret, Roger (Institut des Sciences Nucleaires, Grenoble, France). J. Phys. (Paris), 30: 501-12(July 1969). (In French).

By means of several experimental techniques (scintillation and Ge(Li) γ-ray spectrometers, coincidence techniques and a magnetic β-ray spectrometer), the decay scheme of ^{117}Cd produced by the ^{116}Cd(n,γ) reaction was investigated. The half-lives of ^{117g}Cd and ^{117m}Cd were measured and a decay scheme is proposed for each of these isomers. Including these results in a summary of observed low-lying levels of odd-A isotopes of indium, some theoretical interpretations of these levels are suggested. (auth)

5420 PRECOMPOUND PARTICLES IN THE ^{118}Sn(p,n)^{118}Sb REACTION. Parthasaradhi, K.; Sastry, D. L. (Andhra Univ., Waltair, India). Nuovo Cim., 63B: 511-14(Oct. 11, 1969).

The ^{118}Sn(p,n)^{118}Sb reaction spectra at three bombarding energies of 14, 12, and 10 MeV were analyzed for precompound particles utilizing the expressions of Griffin. It was found that the region of dominance of precompound particles increases as the bombarding energies increase. A qualitative explanation of the variation of the nuclear temperature with bombarding energy as well as with residual excitation energy is presented. (auth)

5421 ISOLDE: NEW APPROACH TO NUCLEAR STRUCTURE STUDIES OF SHORT-LIVED NUCLIDES. Kjelberg, A.; Pappas, A. C. Atoomenergie Haar Toepass., 11: 207-9; 212-17(Sept. 1969).

The Isotope Separator On-Line project at CERN is described. The development of the experimental facilities is briefly described and the research goals and future developments are discussed. (J.W.R.)

5422 INVESTIGATION OF BAND-MIXING ANOMALIES IN ^{152}Sm. Fraser, I. A.; Greenberg, J. S.; Sie, S. H.; Stokstad, R. G.; Burginyon, G. A.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. Phys. Rev. Lett., 23: 1047-51(Nov. 3, 1969).

Multiple Coulomb-excitation measurements of absolute transition-matrix elements from β-band states in ^{152}Sm indicate that the previously reported discrepancies with band mixing arise from a source different from that previously suggested; the matrix elements for the $2_\beta \rightarrow 2$, $0_\beta \rightarrow 2$, and $2_\beta \rightarrow 0$ transitions are consistent with a band-mixing parameter $Z_0 \simeq 0.08$, although an inconsistency remains for the $2_\beta \rightarrow 4$ transition. Angular correlation studies show that $\delta(2_\beta \rightarrow 2) = -67^{\pm}$ and $\delta(4_\beta \rightarrow 4) = -2.94^{\pm}$. (auth)

5423 E2 MATRIX ELEMENTS BETWEEN HIGH-SPIN STATES IN THE GROUND-STATE BANDS OF ^{152}Sm AND ^{154}Sm. Fraser, I. A.; Greenberg, J. S.; Sie, S. H.; Stokstad, R. G.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. Phys. Rev. Lett., 23: 1051-4(Nov. 3, 1969).

Measurements of transition-matrix elements between states with spin up to 10^+ in the ground-state bands of ^{152}Sm and ^{154}Sm indicate large deviations from the adiabatic rotational-model predictions in ^{152}Sm but not in ^{154}Sm. The nonrotational effects are compared with band mixing deduced from β-band de-excitation matrix elements and with measurements of changes in the mean-square radius with increasing spin. (auth)

5424 ROLE OF DOORWAY STATES IN NEUTRON CAPTURE IN ^{93}Nb RESONANCE. Rimawi, Karim; Chrien, R. E.; Garg, J. B.; Bhat, M. R.; Garber, D. I.; Wasson, O. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 23: 1041-4(Nov. 3, 1969).

A comparison between the γ-ray spectra following the capture of $l = 0$ and $l = 1$ neutrons in niobium shows characteristic differences which are not expected with a purely statistical model of compound nucleus decay. The data suggest that the strong E1 γ rays are due to particle-hole annihilations across the $Z = 50$ proton shell, and demonstrate the influence of two-particle, one-hole "doorway" states in the neutron capture process. (auth)

5425 ANOMALOUS ELECTRON SCATTERING FROM ^{142}Nd. Madsen, D. W.; Cardman, L. S.; Legg, J. R.; Gundersheim, E. F.; Bockelman, C. K. (Yale Univ., New Haven). Phys. Rev. Lett. 23: 1122-4(Nov. 10, 1969).

An electron accelerator was used to study elastic electron scattering from ^{142}Nd. The energy was varied between 15 and 60 MeV, while angular distributions were obtained at angles between 70 and 150°. The results indicate an anomalously small skin thickness. A comparison with the effect of dispersion corrections on the interpretation of muonic x-ray results suggests that similar corrections are needed in the present case. (auth)

5426 POSSIBILITY OF THE TRANSITION OF ^{242m}Am TO ^{242}Am UNDER THE ACTION OF SLOW NEUTRONS. Romanov, Yu. F. Yadern. Fiz., 9: 1328-9(June 1969). (In Russian).

Slow neutrons as a result of interaction with nuclei in an isomeric state can remove excitation energy, and thus acquire additional kinetic energy. This process can be measured by comparing the number of nuclei before and after irradiation in a high total flux of neutrons. In the case of ^{242m}Am (T = 152 years), this isomer decays to the ground state of ^{242}Am (T = 16 hours) which in turn decays to ^{242}Cm. By comparing the alpha activity of the target before and after the irradiation it is possible to determine the cross section for this reaction. It was found that the cross section for this process was less than 420 barns. Corrections had to be applied for the ^{241}Am content in the sample. Higher enrichment of the sample in ^{242m}Am would give more accurate results. (TTT)

5427 MECHANISM OF NUCLEAR REACTIONS INDUCED BY HIGH-ENERGY α PARTICLES. I. REACTIONS ^{206}Pb(α,xn)$^{210-x}$Po. Bimbot, R.; Jaffrezic, H.; Le Beyec, Y.; Lefort, M.; Vigny-Simon, A. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 30: 513-20(July 1969). (In French).

As a first step in a more general study of α-induced reactions on heavy nuclei, excitation functions were measured from 40 to 150 MeV for the reactions ^{206}Pb(α,xn)$^{210-x}$Po, with x up to 12, by induced activity methods. The experimental cross sections for each of the individual reactions were added, and the sum is compared with the optical model total cross section. This comparison shows that, above 60 MeV, (α,xn) reactions account for a small fraction of the total inelastic cross section. Even if the fission cross section is added, the value obtained is less than 50% of the inelastic cross section above 100 MeV. Secondly, theoretical evaporation calculations were used to estimate, in each of the individual reactions, the part which can be attributed to a compound-nucleus mechanism, and the same method has given the total cross section for the formation of a compound nucleus, which corresponds to a probability of 0.4 at 80 MeV. Therefore the non-compound nucleus mechanism is important, as it is shown by the non-compound nucleus part of (α,xn) excitation functions. An attempt was made to explain this part by an (α,N) knock-out followed by the evaporation of (x−1) neutrons. It was found that this mechanism cannot entirely explain the high energy tails observed. (auth)

5428 NEW ISOTOPES ^{22}O, ^{20}N, AND ^{18}C PRODUCED IN TRANSFER REACTIONS WITH HEAVY IONS. Artukh, A. G.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A137: 348-52 (1969).

The new isotopes ^{22}O, ^{20}N and ^{18}C were produced in transfer reactions by bombarding ^{232}Th with the ^{18}O ions accelerated in the Dubna heavy ion cyclotron. The combination of the magnetic analysis and the ΔE × E method was used to identify the isotopes. (auth)

5429 PARITY MIXING IN THE 482-keV TRANSITION OF ^{181}Ta. Bodenstedt, E.; Ley, L.; Schlenz, H. O.; Wehmann, U. (Univ., Bonn). Nucl. Phys., A137: 33-50(1969).

The parity impurity of the 482-keV gamma transition of ^{181}Ta was investigated by a measurement of the circular polarization. The polarimeter construction is based on the polarization dependence of the Compton scattering cross section for magnetized iron. A 4π back-scattering geometry is applied in order to reach a high circular polarization detection efficiency combined with a large transmission. The scattered radiation is detected simultaneously by six large plastic scintillators, each of which is connected to a fast scaling system. Possible reasons for systematic errors are carefully investigated. Systematic asymmetries of the polarimeter were measured by use of the 497-keV gamma radiation of ^{103}Rh. One does not expect a circular polarization for this radiation. The circular polarization of the 482-keV transition in ^{181}Ta was $P_\gamma = -(2.8 \pm 0.6) \cdot 10^{-5}$. The error is the standard deviation. The result is compared with theoretical predictions and previous experiments. (auth)

5430 DIFFERENTIAL SPECTRA OF THE INTERNAL BREMSSTRAHLUNG FROM THE FIRST-FORBIDDEN BETA DECAY OF ^{143}Pr AND ^{204}Tl. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary); Scharbert, T.; Vatai, E.; Bruechner, E. Nucl. Phys., A137: 80-4(1969).

In the case of both the non-unique first-forbidden ^{143}Pr decay and the unique first-forbidden ^{204}Tl decay, the integral measurements performed on the internal bremsstrahlung (IB) spectrum contradict each other and the pertaining theories. On the basis of differential measurements at 90° carried out with special care to eliminate any possible instrumental distortion effects, it was found that in the case of the IB spectrum from the non-unique first-forbidden decay of ^{143}Pr, no real deviation from the Nilsson corrected KUB theory seems probable. In the case of the unique first-forbidden decay of ^{204}Tl, this study confirms the presence of a positive deviation of the experimental IB spectrum from both the allowed and the forbidden theoretical ones in a wide region of the spectrum. (auth)

5431 POPULATION OF NUCLEAR ENERGY LEVELS VIA PHOTON-EXCITED LEVELS. Michalk, V. E.; McIntyre, J. A. (Texas A and M Univ., College Station). Nucl. Phys., A137: 115-28(1969).

Energy levels for several nuclei (^{110}Cd, ^{112}Cd, ^{118}Sn, and ^{141}Pr) in the 6 to 8 MeV energy region are excited by neutron-capture gamma-rays from a nuclear reactor. The gamma decays of these levels to low-lying levels in the nuclei were studied using a 30 cc Ge(Li) detector. From angular distribution measurements of the gamma rays, the spins and branching ratios for various levels were deduced. It is shown that such studies extend, as well as complement, the results of other methods used to study the properties of nuclear energy levels. (auth)

5432 PRECISE MEASUREMENTS OF ABSOLUTE γ INTENSITIES FOR α EMITTERS. Peghaire, A. (CNRS, Orsay, France). Nucl. Instrum. Methods; 75: 66-70(1969). (In French).

The intensities of the γ transitions per α decay in the energy interval between 50 keV and 325 keV have been accurately measured. Two main methods have been used for this purpose, according to the different nuclide to be studied: comparison between direct α and γ ray spectrum (^{241}Am and ^{227}Th) and bidimensional α-γ coincidence spectra (^{230}U, ^{228}Th, and ^{226}Th). With this latest method several internal conversion coefficients were measured and found in good agreement with the Pauli's tables. In other cases where the γ-rays are very weakly converted (^{222}Ra and ^{224}Ra) an indirect method was used for determining the γ-intensities using the theoretical values contained in the previous tables. With this set of γ emitters it becomes possible to determine accurately the absolute efficiency of the γ detectors [Ge(Li) for instance]. (auth)

5433 REDETERMINATION OF DELAYED NEUTRONS FROM ^{252}Cf. Chulick, E. T. (Washington Univ., St. Louis); Reeder, P. L.; Eichler, E.; Bemis, C. E. Jr. Radiochim. Acta, 12: 164-6(Oct. 1969).

The half-lives and abundances of delayed-neutron groups formed in the spontaneous fission of ^{252}Cf were redetermined. Half-lives of 0.5 ± 0.1, 2.0 ± 0.3, 6.1 ± 1.4, and 26.8 ± 1.1 sec and relative abundances of 0.17 ± 0.05, 0.30 ± 0.03, 0.22 ± 0.02, and 0.31 ± 0.01 respectively were found. (auth)

5434 STUDY OF γ RADIATION CONNECTED WITH MsTh2 ^{228}Ac DECAY. Arnoux, Micheline; Gizon, Andree (CEN, Grenoble, France). Compt. Rend., Ser. B, 269: 317-20(Aug. 18, 1969). (In French).

With the help of Ge(Li) detectors, a determination is made of the energies and intensities of γ transitions accompanying the decay ^{228}Ac (MsTh2, $T_{1/2} = 6.1$ h) → ^{228}Th. (tr-auth)

Nuclear Theory

Refer also to abstracts 4477, 5226, 5260, 5281, and 5391.

5435 (AD-690873) NEUTRON CHARGE DISTRIBUTION. Ferriter, Nicholas Mark (Naval Postgraduate School, Monterey, Calif.). Dec. 1968. 36p. CFSTI.

Thesis.

The effects of a neutron charge distribution are considered. The effects of this charge distribution for various values of the parameters are shown. The effect of the neutron becomes appreciable in carbon above the diffraction minimum. (auth) (USGRDR)

5436 (AERE-M-2248) SUBROUTINES INTEG B AND DRAWG OF THE MONTE CARLO PROGRAMME SPECIFIC. Blow, S.; Lipscombe, B. A. (Atomic Energy Research Establishment, Harwell (England)). Sep 1969. 10p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

SPECIFIC is a Monte Carlo code for the estimation of high energy neutron spectra from a fission source in cylindrical geometry. Flux values are derived from collision density results, and from track-length estimates. Variance values are associated with results from the latter estimate. An option is available for integrating tabulated functions over the derived neutron spectrum. SPECIFIC was written in FORTRAN for the IBM 7030 machine (STRETCH) by M. P. Ruffle. In converting SPECIFIC from the IBM 7030 to the Harwell 360/65 machine the original graph-plotting sub-routine had to be dropped because of diminished core space. A new graph routine, incorporating the "graph-package" library sub-routine OBO7A, has now been implemented and is described. The name of the sub-routine which originally performed the integrations is INTEG (it is still available in the program). During use, two limitations of INTEG became apparent. Firstly, under certain physical conditions (high cross-section values for a tabulated function in a low energy region where the flux was small or zero) INTEG gave an incorrectly high value for the error estimate. Secondly, and this is a basic limitation, INTEG processes all the information and performs all the integrals in one step. This method imposes somewhat complicated limitations on the sizes of the FORTRAN variable arrays and of the number of integrals which can be performed at one run of SPECIFIC. INTEG B was therefore written in order to correct the method of error estimation, and to perform the integrations sequentially. Up to 10 integrand functions can be combined (as a product) in one integral. The upper limit of all integrals is 14.0 MeV and the lower limit is the cut-off energy. (W.H.K.)

5437 (BNL-tr-169) DIRECT EXCITATION OF NUCLEAR FISSION DEGREES OF FREEDOM AT LOW ENERGIES. Vorotnikov, P. E. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz., 5: 1021-7(1967). 15p. Dep. CFSTI.

A comparison of fission widths Γ_f is carried out for the nuclear fission induced by γ-rays, fast and slow neutrons. Γ_f is shown to depend strongly on the angular momentum transferred to the nucleus by the incident particle, while the angular momentum, parity, and internal structure of the target nucleus have a weak influence on Γ_f. It follows the conclusion about the direct excitation of fission degrees of freedom and about the connection between the symmetry character of the fissionable nucleus and the transferred angular momentum. The excitation exchange between one-particle and collective degrees of freedom seems to be a slow process as compared with the fission of an asymmetrical deformed nucleus. The height of the fission potential barrier exceeds considerably the value now accepted. (auth)

5438 (COO-1764-70) PAIRING COLLECTIVE DEGREE OF FREEDOM. Bes, D. R.; Broglia, R. A.; Perazzo, R. P. J. (Minnesota Univ., Minneapolis). [nd]. 4p. (CONF-690804-16). Dep. CFSTI.

From International Conference on Properties of Nuclear States, Montreal, Canada.

A collective treatment of the pairing force problem was developed in terms of two parameters: the intrinsic deformation α and the Gauge angle ϕ. The comparison between the results obtained with the resultant quantum mechanical Hamiltonian and those obtained by an exact diagonalization shows the adequacy of the present approach. (auth)

5439 (FEI-133) TOWARD A THERMODYNAMIC DESCRIPTION OF THE ENERGY SPECTRA OF ATOMIC NUCLEI. Sokolov, Yu. V.; Stavinskii, V. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR [Obninsk]. Fiziko-Energeticheskii Institut). 1969. 33p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An attempt is made to construct a thermodynamics of atomic nuclei from available spectroscopic data on (p,p′) and (d,p) reactions. The total energy spectrum and the statistical weights of each level are not available. Part of the levels may be missing. The function of the state of the nucleus is described as the summation of the statistical weight of a level multiplied by exponential term involving the energy of that state. Hence it is desirable to take into account as many levels as possible at as high an energy as possible in order to obtain a more accurate determination of the function of state. Hence only data for the nuclei ^{41}Ca, ^{51}Cr, ^{55}Fe, ^{58}Fe, ^{59}Ni and ^{61}Ni were examined. The excitation energy is taken as the average energy of the system minus the energy of ground state. These functions are described for models of independent Fermi particles, of a liquid drop and of an ideal gas. Various types of spectra are assumed in order to estimate the effect of a lack of data. The equation of state could not be derived. However the calculations show that in order to construct a thermodynamics of nuclei it is necessary to have reliable information on the statistical weights of the states. It is also necessary to know the spectrum up to an energy of 20 MeV. (TTT)

5440 (JINR-4-4109) NOMOGRAMS FOR RESOLVING PROBLEMS ON KINEMATICS OF NUCLEAR REACTIONS OF THE I + II = 1 + 2 AT NONRELATIVISTIC ENERGIES. Potetyunko, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. (In Russian). Dep. CFSTI (U.S. Sales Only).

Nomograms are given to solve problems of an incident particle striking a target particle to give a light reaction product and a recoil nucleus. The problems include the conversion of angles of emission from the laboratory system of coordinates (LSC) to the center-of-mass system (CMS), the determination of the angle θ_2 from a known θ_1 (or the converse), the conversion of differential effective cross-sections from LSC to CMS, the determination of the beam energy in LSC from known values of θ_1 (angle of emission of the incident particle in LSC) and of Q (energy liberated during reaction), and the determination of Q for known values of E_1 and θ_1. The basic formulas for the nonrelativistic case are presented, and the methods of constructing and using the nomograms are illustrated. (TTT)

5441 (JINR-P2-4661) CASCADE MODEL OF PHOTONUCLEAR REACTIONS. Gudima, K. K.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The intranuclear cascade model, used previously for investigation of π-meson- and nucleon-nucleus collisions, is applied in studying inelastic interactions of high energy γ-quanta with atomic nuclei. The results are in good agreement with the available experimental data. (auth)

5442 ELECTROEXCITATION OF J/suppi/ equals 1^-, T equals 0 LEVELS IN SELF-CONJUGATE NUCLEI AND NUCLEAR COMPRESSIBLE MODE. Fujii, Saburo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 42: 416-18(Aug. 1969).

It is shown that E1 excitation with $\Delta T = 0$ in self-conjugate nuclei arises from nuclear compressibility. The compressible modes are easily distinguished from deformable modes. The experimental form factor for the 10.8-MeV level of ^{12}C is fairly well reproduced assuming such an excitation mode. (J.W.R.)

5443 SHELL-MODEL CALCULATION OF FORM FACTORS FOR ONE-NUCLEON TRANSFER REACTIONS. Igarashi, Masamichi; Kawai, Mitsuji; Yazaki, Koichi (Tokyo Inst. of Tech. Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 245-74(Aug. 1969).

The method of calculating the form factor for a stripping or a pick-up reaction proposed in a previous paper is applied to a simple case of the neutron transfer reaction involving a nucleus with two particles or holes plus a closed shell core. The formula for the overlap integral which gives the form factor is presented in the form convenient for the actual calculation. The numerical calculation is performed for the case of neutron pick-up reaction on ^{18}O and the result is compared with that obtained by the conventional separation energy method. It is found that the two are very similar, but that the overlap integral obtained by the present method tends to be shifted towards the outer region compared to that obtained by the separation energy method. The formal structure of the method is also studied in detail and is compared with those of other similar methods. Discussion is given in particular on the accuracy of the method, the effect of the Pauli principle and the effective interaction used in the calculation. The present method is found to be particularly suited for the test of the model wave function used in the form factor calculation. (auth)

5444 CENTER-OF-MASS LOCALIZATION IN SELF-BOUND MANY-BODY SYSTEMS. Puff, R. D. (Univ. of Washington, Seattle). Ann. Phys. (N. Y.), 55: 77-106(Oct. 15, 1969).

The problem of self-localization in bound many-body systems is examined, with emphasis on the attempt to calculate density distributions relative to the center-of-mass and thereby examine properties of the surface. Such distributions $\bar{\rho}(r)$ can be formally calculated in several ways; in terms of off-diagonal matrix elements of the ordinary density, in terms of new field amplitudes with nonlocal commutation relations, or in terms of diagonal elements of the ordinary density evaluated in states of an extended (translational symmetry-broken) Hamiltonian. The first two methods appear rather intractable for practical calculations, whereas the third formulation allows a simple exact solution for oscillator forces and is capable of extension to other interactions of interest. In view of the use to which oscillator states have been put in nuclear shell model calculations, some of the difficulties inherent in an oscillator model calculation of the density $\bar{\rho}(r)$ for large nuclei are noted. (auth)

5445 EXAMPLES OF PARASTATISTICS. Cusson, R. Y. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Ann. Phys. (N. Y.), 55: 22-40(Oct. 15, 1969).

The pairing model of nuclear physics for a single j shell is shown to define a para-Fermi statistics of order $j + \frac{1}{2}$; the parafermion is a pair with total spin zero and is usually represented by the quasi-spin raising operator of Kerman. The description of a single spin $\frac{1}{2}$ fermion in a 3-dimensional harmonic oscillator with spin-orbit force is next shown to define a para-Bose statistics of order 3; the paraboson is a quantum of excitation with total spin zero and is Joseph's self-adjoint ladder operator for the harmonic oscillator. In neither case do there exist Klein transformations which reduce the formalism to ordinary statistics. A model field theory of a cluster is discussed and shown to present strong analogies with parastatistics. A new structure ansatz complementing Green's ansatz for a parafield is given and used to establish the equivalence of Greenberg's paraquark model of the nucleon and Nambu's three-triplet model. It is suggested that paraquanta may represent "composite" particles having an "intrinsic" form factor and nonlocal properties and as such might be better viewed as "elementary excitations" of the system. (auth)

5446 CHARACTERISTICS OF THE INTERACTION OF HIGH-ENERGY NUCLEONS WITH NUCLEI. Konshin, V. A.; Matusevich, E. S. (Inst. of Physics and Power Engineering, Obninsk, USSR). At. Energy Rev., 6: No. 4, 3-79(Dec. 1968).

The characteristics of the basic processes of interaction between high-energy (hundreds of MeV) nucleons with nuclei are reviewed taking as the starting point the requirements of calculations for radiation shielding against high-energy protons. Theoretical and experimental data relating to the cross-sections for the inelastic interaction of nucleons with nuclei, and data on the number and type of cascade and evaporated particles and on their angular and energy distributions are discussed. (auth)

5447 SUPERHEAVY ELEMENTS IN NATURE. Meldner, H. (Freie Univ., Berlin); Herrmann, G. Z. Naturforsch., 24a: 1429-30(Sept. 1969).

Recent estimates of alpha and spontaneous fission half-lives near the conjectured magic numbers Z = 114 and N = 184 are discussed. A possible non-existence of a significant N = 184 shell is suggested. The effects of odd proton and neutron numbers on the stability in this region are discussed. In contrast to other estimates, the elements Z = 111 and Z = 113 are suggested as the candidates for superheavy nuclei with the longest half-lives. (J.W.R.)

5448 GENERALIZED CLUSTER DECOMPOSITION OF THE S-MATRIX. Jacobson, D. A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Nuovo Cim., 63B: 515-38 (Oct. 11, 1969).

The cluster decomposition of the S-matrix for arbitrary measurements (including nonasymptotic measurements) is derived from a generalized first cluster property. The corresponding connected part of the S-matrix is then shown to satisfy a connected unitarity relation containing terms not present when only asymptotic measurements are considered. (auth)

5449 EFFECT OF THE STATISTICAL COMPOUND NUCLEUS PROCESS IN ELASTIC SCATTERING MEASUREMENTS. Dallimore, P. J. (Australian National Univ., Canberra). Aust. J. Phys., 22: 443-6(Aug. 1969).

The errors in elastic scattering cross-section calculations due to a statistical component are investigated. It is found that the spin of the target nucleus is a major parameter in the estimation of these errors. (auth)(Australia)

5450 VALIDITY OF ZERO-RANGE (d,p) CALCULATIONS. Smith, William R. (Trinity Univ., San Antonio). Phys. Rev. Lett., 23: 1045-7(Nov. 3, 1969).

Theoretical zero-range and finite-range (d,p) angular distribution shapes are nearly identical; however, the cross sections differ in magnitude by a factor proportional to the square of the normalization of the deuteron internal wave function but independent of the corresponding potential. If a Hamada—Johnston wave function is used, then this zero-range multiplying factor is 2.38. (auth)

5451 MULTICHANNEL SCHROEDINGER EQUATION WITH NONLOCAL SEPARABLE POTENTIAL. Chan, H. H. (Queen's Univ., Kingston, Ont.); Razavy, M. Nuovo Cim., 63B: 441-6 (Oct. 11, 1969).

A multichannel Schroedinger equation with nonlocal separable potential is studied in some detail. The partial-wave amplitude (matrix) is found in closed form and is compared with the ND^{-1} representation. Though this partial-wave amplitude (without CDD poles) belongs to the class of amplitudes that Warnock has considered, it cannot be expressed simply as the ratio of two matrices ND^{-1}. (auth)

5452 NUCLEAR SHELL MODEL. De-Shalit, A. (Weizmann Inst. of Science, Rehovoth, Israel). pp 307-27 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

Some of the basic problems in nuclear physics are discussed. They include the extent to which nuclei can be described by using the nucleon co-ordinates only, the possible meaning of the success of the shell model in interpreting some of the data on energies of nuclei and their electromagnetic properties, recent studies on the Hartree–Fock approximation, and the possible conclusions to be drawn from two-body correlations in nuclei. (auth)

5453 NUCLEAR PHYSICS AND THE MANY-BODY PROBLEM. Thouless, D. J. (Univ. of Birmingham, Eng.). pp 329-40 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

A review is given of the use that has been made of stationary and time-dependent Hartree–Fock theory in nuclear physics. There is also a discussion of the oscillations in charge density expected from the shell model of nuclei and their bearing on the properties of nuclear matter. (auth)

5454 MICROSCOPIC THEORY OF EFFECTIVE OPERATORS OF ELECTROMAGNETIC INTERACTIONS IN NUCLEI. Sawicki, J. (International Centre for Theoretical Physics, Trieste, Italy). pp 341-3 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The use of realistic two-nucleon potentials in microscopic theories of nuclear structure makes it possible to calculate effective electromagnetic operators. E2- and M1-operators for ^{118}Sn are calculated from the Yale–Shakin potential in terms of particle-hole excitations and are applied to the calculation of observable quantities. (auth)

5455 EXCITATIONS IN NUCLEI. Bohr, A. (Univ. of Copenhagen). pp 345-58 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

Some of the problems in attempts to describe nuclear excitation are surveyed. The topics discussed include the spectrum of elementary excitations, static deformations and rotational spectra, the relationship between members of a collective family, analysis of collective parameters, spurious degrees of freedom, and pairing modes. (J.W.R.)

5456 NUCLEAR EXCITATIONS OF SPECIAL SYMMETRY. Temmer, G. M. (Rutgers–The State Univ., New Brunswick, N. J.). pp 359-70 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The current status of isobaric spin symmetry in nuclear physics is surveyed. The working rules used in studying the formation of higher isospin states are discussed. The problems of Coulomb mixing and T-forbidden resonances are described. Some examples from the literature are presented. (J.W.R.)

5457 MICROSTRUCTURE IN NUCLEAR SPECTRA AT HIGH EXCITATION. Ericson, T. E. O. (CERN, Geneva). pp 371-9 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The statistical microstructure of highly excited systems is illustrated by the distribution and fluctuations of levels, widths and cross sections of nuclei both for the case of sharp resonances and the continuum case. The coexistence of simple modes of excitation with statistical effects in terms of strength functions is illustrated by isobaric analog states. The analogy is made with similar phenomena for coherent light, solid-state physics, and high-energy physics. (auth)

5458 DISTRIBUTION OF ENERGY LEVEL SPACINGS AND CONSERVATION LAWS. Rosenzweig, N. (Argonne National Lab., Ill.). pp 381-90 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The random-matrix model, which provides a basis for deriving the statistical laws which govern the level fluctuations and decay widths of highly excited nuclei, is discussed. The dependence of the statistical properties on the symmetries of the quantum mechanical system is emphasized. Atomic spectra and the thermodynamic properties of small metallic particles are discussed in addition to nuclear spectra. (J.W.R.)

5459 NUCLEAR SYMMETRIES. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.). pp 391-7 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

A variety of symmetries in nuclei are discussed; although none of them are pure many properties connected with symmetry are found in low-lying states. (auth)

5460 S-MATRIX IN NUCLEAR PHYSICS. Feshbach, H. (Massachusetts Inst. of Tech., Cambridge). pp 399-427 of Contemporary Physics: Trieste Symposium 1968. Vol. II. Vienna, International Atomic Energy Agency, 1969.
From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.2); CONF-680629(Vol.2).

The role of the S-matrix in nuclear reaction theory is reviewed. The use of S-matrix for the various reaction types and mechanisms is discussed and some examples are presented. Some of the difficulties and unsolved problems in nuclear reaction theory are examined. (J.W.R.)

5461 STRETCH STATES EXPANSION IN TERMS OF STATES WITH WELL-DEFINED SYMMETRY PROPERTIES. Feneuille, S. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A137: 229-40(1969).

A method is described which allows one to expand any stretch state in terms of states with well-defined symmetry properties in the seniority scheme and isospin formalism. Some results obtained in simple particular cases are given. (auth)

5462 MICROSCOPIC DESCRIPTION OF NUCLEAR ROTATION BY GENERALIZED GREEN FUNCTIONS. Meyer, J. (Technische Hochschule, Munich). Nucl. Phys., A137: 193-210(1969).

The theory of nuclear rotational spectra is reformulated in terms of generalized Green functions. Using projected wave functions, a reduction procedure for three-dimensional rotational matrix elements is derived, taking into account the change of the intrinsic nuclear density distribution due to rotation. In first order the reduced equation of motion corresponds to cranking Green functions; higher order corrections are obtained. The determination of the collective energy spectrum is discussed, and a compact expression for multipole transition elements is derived in terms of the reduced density matrix. (auth)

5463 GENERALIZED SENIORITY FOR FAVORED $J \neq 0$ PAIRS IN MIXED CONFIGURATIONS. Hecht, K. T.; Adler, A. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A137: 129-43 (1969).

By assigning a pseudo-spin and pseudo-orbital angular momentum (b-spin and c-spin) to the single-particle states in a mixed configuration of identical nucleons, it is possible to classify as $B = 0$ objects both the favored pair operators of the surface delta interaction (SDI) and the multipole moment operators, (the latter under suitable assumptions). The favored pair is defined for each J as the specific superposition of two-particle states acted upon by this separable interaction. The SDI is diagonal in the total B- and C-spins; the eigenvalues of a (B, C) multiplet are independent of the total angular momentum J, ($J = B + C$); and all states with $B = \frac{1}{2}v$ are degenerate (v = total seniority). For the case of a degenerate doublet of levels $(l_j, (l+2)_{j+1})$, e.g., $(d_{5/2}g_{7/2})$ or $(f_{7/2}h_{9/2})$, the specification, $B = 0$, defines the favored pairs uniquely, and 2B counts the number of nucleons not members of favored pairs. Exact calculations for the $(d_{5/2}g_{7/2})$ system show that states with $B < \frac{1}{2}v$ cluster closely about their centers of gravity; therefore, to a good approximation the SDI can be replaced by a generalized pairing interaction depending only on B and v. Possible generalizations are discussed for the case of many degenerate single-particle levels, where this generalized pairing interaction is no longer a good approximation. (auth)

5464 THREE-BODY FORCES IN NUCLEAR MATTER. Brown, G. E. (State Univ. of New York, Stony Brook); Green, A. M. Contract AT(30-1)-4032. Nucl. Phys., A137: 1-19(1969).

An earlier claim about the smallness of three-body effects in nuclear matter is examined in the light of a criticism. The conclusion is that, whereas the lowest-order three-body effect is small, second-order effects are larger, with the net result of ≈2.5 MeV per particle additional binding at the saturation density. Although these results depend on the way one extrapolates off the pion mass shell, different ways which seem to be reasonable give roughly the same result. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 4353.

5465 (APDA-CFE-33) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, MAY 1969. Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). May 1969. Contract AT(11-1)-865. 42p. Dep. CFSTI.

The status of the Fermi Fast Breeder Reactor primary sodium system and gas systems is summarized. Steam generator and gas systems performance are described. Radioactive waste disposals are tabulated. The photographic survey of the holddown mechanism is detailed; the status of plant modifications, under construction, is summarized. Installation of a new primary shield tank boot seal and repair of the No. 1 primary sodium pump are described. Neutron detector channel malfunction is discussed. (M.L.S.)

5466 (APDA-CFE-34) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, JUNE 1969. Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Oct 1969. Contract AT(11-1)-865. 38p. Dep. CFSTI.

The status of the primary sodium system of the Fermi Fast Breeder Reactor, as of June 1969, is summarized. Performance of primary cover gas system and steam generators is discussed. Data on the continuous environmental survey are given. Status of plant modifications is described briefly. Results of leak testing of the new primary shield tank boot seal are presented; preparations for replacement of the No. 1 safety rod lower guide tube are detailed. Results of corrosion inspection, isolation tests, and vacuum relief valve tests for the containment system are summarized. (M.L.S.)

5467 (DOCKET-1155-10) LA CROSSE BOILING WATER REACTOR. Application for Transfer of Provisional Operating Authorization DPRA-5. (Dairyland Power Cooperative, La Crosse, Wis.). 27 Oct 1969. 3p. Dep. CFSTI.

5468 (DOCKET-1155-12) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 27, September 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 30 Oct 1969. 21p. (ACNP-69510). Dep. CFSTI.

5469 (DOCKET-1155-13) LA CROSSE BOILING WATER REACTOR. Provisional Operating Authorization and Technical Specifications. (Dairyland Power Cooperative, La Crosse, Wis.). 31 Oct 1969. 62p. Dep. CFSTI.

The Provisional Operating Authorization which allows the Dairyland Power Cooperative to use and operate the La Crosse Boiling Water Reactor is presented. The complete set of Technical Specifications is included also. (M.L.S.)

5470 (DOCKET-50003-14) INDIAN POINT UNIT NO. 1. Emergency Core Cooling Report. (Consolidated Edison Co. of New York, Inc., New York). Sep 1968. 118p. Dep. CFSTI.

Emergency core cooling provisions for the Indian Point Power Reactor, Unit 1 are examined in detail. The pressure differences across major components are evaluated during the subcooled phase of blowdown; blowdown effects on core vessel internals are analysed. Primary coolant system inventory and pressure during blowdown are calculated; core thermal effects are considered. Effects of coolant loss accidents on containment pressure are discussed. Mechanical, structural, and electrical modifications to the power plant are described. 12 references. (M.L.S.)

5471 (DOCKET-50003-16) [INDIAN POINT UNIT NO. 1.]. Request for Full Term Operating License. (Consolidated Edison Co. of New York, Inc., New York). 10 Nov 1969. 7p. Dep. CFSTI.

5472 (DOCKET-50003-17) INDIAN POINT STATION, [UNIT NO. 1]. Semiannual Operations Report No. 14, April 1–September 30, 1969. (Consolidated Edison Co. of New York, Inc., New York). 24 Nov 1969. 35p. Dep. CFSTI.

5473 (DOCKET-50029-108) YANKEE NUCLEAR POWER STATION. Operation Report No. 74, February 1967. (Yankee Atomic Electric Co., Boston, Mass.). 17 Mar 1967. 8p. Dep. CFSTI.

5474 (DOCKET-50171-12) PEACH BOTTOM ATOMIC POWER STATION. Monthly Operations Report No. 43, September 1969. (Philadelphia Electric Co., Pa.). 6 Nov 1969. 12p. Dep. CFSTI.

5475 (DOCKET-50206-20) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 1, September 5, 1964–January 8, 1965. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 14p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5476 (DOCKET-50206-21) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 2, January 5–April 2, 1965. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 15p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5477 (DOCKET-50206-22) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 3, April 1–July 25, 1965. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 16p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5478 (DOCKET-50206-23) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 4, July 1–September 30, 1965. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 15p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5479 (DOCKET-50206-24) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 5, October 1–December 31, 1965. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 23p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5480 (DOCKET-50206-25) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 6, January 1–March 31, 1966. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 16p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5481 (DOCKET-50206-26) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 7, April 5–July 8, 1966. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 16p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5482 (DOCKET-50206-27) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 8, July 1–September 30, 1966. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 15p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5483 (DOCKET-50206-28) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 9, October 1–December 31, 1966. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 16p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5484 (DOCKET-50206-29) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 10, January 1–March 31, 1967. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 23p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5485 (DOCKET-50206-30) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 11, April 1–June 30, 1967. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 19p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5486 (DOCKET-50206-31) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 12, July 1–September 30, 1967. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 18p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5487 (DOCKET-50206-32) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Report No. 13, October 1–December 31, 1967. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 18p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5488 (DOCKET-50206-33) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. Re-

port No. 14, January 1–March 31, 1968. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 17p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5489 (DOCKET-50206-34) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Post-Operational Environmental Survey. Fourth Report, 2nd Quarter 1968. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 11p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5490 (DOCKET-50206-35) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Post-Operational Environmental Survey. Fifth Report, 3rd Quarter 1968. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 9p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5491 (DOCKET-50206-36) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Post-Operational Environmental Survey. Sixth Report, 4th Quarter 1968. (Tracerlab/West, Richmond, Calif.). 15 Oct. 1969. 11p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5492 (DOCKET-50206-37) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Post-Operational Environmental Survey. Seventh Report, 1st Quarter 1969. (Tracerlab/West, Richmond, Calif.). 15 Oct. 1969. 12p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5493 (DOCKET-50206-38) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Post-Operational Environmental Survey. Eighth Report, 2nd Quarter 1969. (Tracerlab/West, Richmond, Calif.). 15 Oct 1969. 7p. Dep. CFSTI.
For Southern California Edison Co., Camp Pendleton, Calif.

5494 (DOCKET-50206-39) SAN ONOFRE NUCLEAR GENERATING STATION. Environmental Monitoring Program. (Southern California Edison Co., Los Angeles). 15 Oct 1969. 10p. Dep. CFSTI.

A detailed outline of the environmental monitoring program for the San Onofre Power Reactor, Unit 1 is given. Standards and maximum exposure levels are given for persons, animals, and vegetation as a function of location. Results of the pre-operational and post-operational radiological monitoring programs are summarized briefly. (M.L.S.)

5495 (DOCKET-50206-40) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Report on Circulating Water Intake Stop Gate Failure. (Southern California Edison Co., Los Angeles). 24 Oct 1969. 3p. Dep. CFSTI.

Failure of the circulating water system intake stop gate for the San Onofre Power Reactor, Unit 1 is described. The corrective action taken is specified. (M.L.S.)

5496 (DOCKET-50206-41) [SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1]. Boric Acid Injection System. (Southern California Edison Co., Los Angeles). 27 Oct 1969. 2p. Dep. CFSTI.

Operational experience with a modified boric acid injection system for the San Onofre Power Reactor, Unit 1 is discussed. Final corrective action, taken in November 1968, is described. (M.L.S.)

5497 (DOCKET-50267-14) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Final Safety Analysis Report, Amendment 14, Vol. 1. (Public Service Co. of Colorado, Denver). 4 Nov 1969. 800p. Dep. CFSTI.

FORT ST. VRAIN POWER REACTOR, UNIT 1—site for, final safety analysis of
—core for, final safety analysis of design for (M.L.S.)

5498 (DOCKET-50267-15) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Final Safety Analysis Report, Amendment 14, Vol. 2. (Public Service Co. of Colorado, Denver). 4 Nov 1969. 789p. Dep. CFSTI.

FORT ST. VRAIN POWER REACTOR, UNIT 1—cooling system for, final safety analysis of helium
—reactor vessel for, final safety analysis of prestressed concrete
—engineered safeguards for, final safety analysis of
—control systems and instrumentation for, final safety analysis of
—electrical systems for, final safety analysis of
—emergency and auxiliary systems for, final safety analysis of (M.L.S.)

5499 (DOCKET-50267-16) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Final Safety Analysis Report, Amendment 14, Vol. 3. (Public Service Co. of Colorado, Denver). 4 Nov 1969. 782p. Dep. CFSTI.

FORT ST. VRAIN POWER REACTOR, UNIT 1—steam and power conversion systems, final safety analysis of
—radioactive waste processing and radiation protection at, final safety analysis of
—operation of, final safety analysis of procedures for initial testing and subsequent
—safety analyses of, final
—research and development programs for
—quality assurance program for
—design of, comparison of AEC design criteria and (M.L.S.)

5500 (DOCKET-50267-17) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Final Safety Analysis Report, Amendment 14, Vol. 4. (Public Service Co. of Colorado, Denver). 4 Nov 1969. 892p. Dep. CFSTI.

FORT ST. VRAIN POWER REACTOR, UNIT 1—coolant circulation in, safety analysis of loss of forced
—reactor vessel for, design data and analyses for prestressed concrete (M.L.S.)

5501 (ORNL-TM-2704) PREDICTION OF THE ECONOMICALLY OPTIMUM TIME TO INITIATE RECYCLE FOR THE HIGH-TEMPERATURE GAS-COOLED REACTOR INDUSTRY USING COMPUTER PROGRAM DELAY. Furman, F. J.; Pratt, R. B.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 34p. Dep. CFSTI.

The planning of the recycle technology of high-temperature gas-cooled reactors is described. Cost as a function of throughput curves for fuel fabrication, spent fuel storage, and waste storage was calculated. This information was combined by computer program DELAY, with the mass balances for 1000 MW(e) HTGR's operating with and without benefit of fuel recycle, with assumed growth curves, and with start dates for fuel recycle operations. Sensitive parameters were varied to determine the effect of inaccuracies in the input data. Inspection of the results reveals that recycle operations should begin 5 to 8 years after the first 1000 MW(e) HTGR begins operations. The economic penalty for delay in starting recycle operations was found to be as great as $30 million/year. (auth)

5502 (RD/B/N-1369) FURTHER RESULTS ON TEMPERATURES, RATINGS, AND CONTROL FOR AXIAL LOADINGS WITH A BURNABLE POISON SCHEME. Johnson, P. W. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1969. 23p. Dep. CFSTI (U. S. Sales Only).

The performance aspects of two differential axial enrichment loadings with burnable poisons have been studied. An assessment has also been made of the effect of leaving the outer zone unflattened. Results are presented which demonstrate that a ±10% error in the prediction of the burn-out behavior of the poison may readily be corrected using the grey rods. (auth) (UK)

5503 (TID-25271) LATERAL STRUCTURE: FOUNDATION INTERACTION OF NUCLEAR POWER PLANTS DURING EARTHQUAKE LOADING. Technical Report No. 2. Scavuzzo, R. J.; Bailey, J. L.; Raftopoulos, D. D. (Toledo Univ., Ohio. Research Foundation). Aug 1969. Contract AT(40-1)-3822. 65p. Dep. CFSTI.

The extent to which large reactor structures will interact with free-field seismic ground motion so as to alter the base motion of the structure from free field values is studied. An analysis is presented in which an N-mass structure is coupled to a two-dimensional elastic half space. Interaction between lateral inertial forces and lateral base motion is considered. Rocking effects and vertical interaction have not been taken into account. Furthermore, it is assumed that there is no mass at the foundation of the structure. Numerical results for two free-field acceleration inputs are considered. In the first study a ramp sine function is used as input. The east-west ground acceleration recorded at Golden Gate Park during the March, 1957, San Francisco earthquake is studied in the second case. Various ground stiffnesses and structures are subjected to these motions. Significant interaction effects for nuclear power plants are calculated. 36 references. (auth)

5504 (TRG-Report-1843) REACTION RATE TABLES FOR THE DOUNREAY FAST REACTOR: RUN 59/1. Atkinson, H. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Mar 1969. 63p. Dep. CFSTI (U. S. Sales Only). UK 8s.

Tabulated reaction rates from computer calculations, based on the loading of Run 59/1, are presented. These values are applicable to future loadings similar to 59/1 and, with some reservations, to past loadings with the Ni reflector. The calculations are based on improved methods and data which are described elsewhere, and have been checked against a variety of experimental measurements. A discussion on the accuracy of the data, and on the effects of specimen selfshielding, is included. These tables should not be used for Sector A which has five rows of Ni instead of the normal three rows in the reflector. 5 references. (auth) (UK)

5505 (TRG-Report-1844) REACTION RATE TABLES FOR SECTOR A OF THE DOUNREAY FAST REACTOR: RUN 59/1. Crowe, D. S. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Mar 1969. 32p. Dep. CFSTI (U. S. Sales Only).

The tabulated reaction rates presented were calculated for a reactor loading as for Sector A of Run 59/1. Hence these results are only applicable for Sector A of runs with similar loading to this. They should not be used for any other sector of the reactor. 3 references. (auth)

5506 (TRG-Report-1845) REACTION RATE TABLES FOR THE DOUNREAY FAST REACTOR: RUN 55. Crowe, D. S. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Mar 1969. 63p. Dep. CFSTI (U. S. Sales Only). UK 8s.

The tabulated reaction rates presented were calculated for the reactor loading as it was for Run 55. All sectors of the reactor had a fairly uniform loading for both the core and breeder. There were three sub-assemblies and the core had a two zone loading of Mk3A and Mk3B driver charge elements. The breeder was loaded with: mainly experimental rigs in the first row; nickel elements in the second and third rows; and natural uranium elements in the remainder. These results can also be used for Runs 56, 54 and 53. 8 references. (auth) (UK)

5507 (WCAP-3017-6090) YANKEE CORE EVALUATION PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1969. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct 1969. Contract AT(30-1)-3017. 49p. Dep. CFSTI.

Post irradiation studies were carried out on eighteen Zircaloy-4 clad UO_2 fuel rods from Yankee Core V. The studies included visual inspection, determination of fission gas release, tests of clad tensile and burst properties at elevated temperature, burnup and fast neutron exposure, and fuel and clad metallographic examination. Evaluation of the experimental results is continuing; initial evaluation of the data indicates no anomalous irradiated clad mechanical properties, fission gas release behavior, or radiation-induced microstructure changes in either the fuel or the clad. (auth)

5508 EXPECTED ENVIRONMENTAL EFFECT OF THE NUCLEAR POWER PLANT AT BARSEBAECK. Sviden, Sven. Tek. Tidskr., 99: 607-10(1969). (In Swedish).

The Barsebaeck Power Reactor, Unit 1 between Malmoe and Landskrona will be a 580 MW BWR which is scheduled to be in operation in 1975. Another 3 units are planned. The cooling water will be taken from Oeresund and returned to the strait. The temperature increase of the cooling water is calculated to 8 deg C. Measurements were made to determine the probable raise of temperature of the water in the strait. It was found that the increase at maximum would be 1 deg C at 3 km distance from the outlet. (Sweden)

5509 OPTIMIZATION IN NUCLEAR ENGINEERING AT ITS INITIAL STAGE OF DEVELOPMENT. Frankovski, V. At. Energ. (USSR); 27: 396-402(Nov 1969). (In Russian).

The problem of finding the optimum composition of a system of nuclear power plants at its initial stage of development is a linear programming problem. The optimum programme for a specified period, determined as a part of an optimum programme found for a longer perspective containing this period, does depend on the length of the perspective. 4 references. (auth)

5510 OPERATING EXPERIENCE WITH BELOYARSK NUCLEAR POWER PLANT. Dollezhal, N. A.; Aleshchenkov, P. I.; Evdokimov, Yu. V.; (and others). At. Energ. (USSR); 27: 379-86(Nov 1969). (In Russian).

The results of more than a five year experience with the Beloyarsk Power Reactor are given and some perspectives of the Beloyarsk type reactors development are presented. 9 references. (auth)

5511 APPRAISAL STUDY OF REPORTED OPERATING EXPERIENCES OF VARIOUS FAST BREEDER REACTORS IN THE WORLD. VII. ENRICO FERMI APP AND DOUNREAY FBR IN 1967-1968. Nakagawa, Hiroshi; Futami, Tsuneo (Tokyo Electric Power Co., Inc.). Nippon Genshiryoku Gakkaishi; 11: 679-86 (1969). (In Japanese).

5512 THE ROLE OF DUTCH INDUSTRY IN FUTURE REACTOR CONSTRUCTION. Barendregt, T. J. Atoomenergie Haar Toepass.; 11: 177-84(Jul-Aug 1969). (In Dutch).

The Dutch industry will provide about 76% of the hardware for the Borssele reactor which will be kept under the sole supervision and responsibility of the Siemens Co. The reactor is built under a license from Westinghouse Co. The original design was modified by keeping the radioactive fuel inside the reactor instead of removing it from the containment area. The reactor is expected to be in operation by 1973. Plans are under consideration to have 600 to 800 and 1100 MW reactors by 1975, 1978, and 1980 respectively. It is expected that future Dutch contribution to reactor construction will consist in providing service rather than in the manufacture of hardware; the Dutch industry will probably also play an important role in the enrichment of the fuel and the production of fuel elements. (Interview) (TTT)

5513 CANADA USES CONCRETE FOR AIRTIGHT NUCLEAR PLANT. Eng. Constr. World; 4: No. 10, 6-7; 10; 12; 14(Oct 1968).

The construction of power reactor concrete containment structures in Canada is described. Procedures and problems encountered are presented. (D.C.C.)

Power Reactor Development

Refer also to abstracts 4710, 4735, 4738, and 4817.

5514 (WARD-2000-90) 1000 MWe LMFBR FOLLOW-ON STUDY. TASK IV. FINAL REPORT. Fultonberg, D. N. (ed.) (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Mar 1969. Contract 31-109-38-2000. 495p. Dep. CFSTI.

For Argonne National Lab., Ill.

The results of the Westinghouse research and development studies for the conceptual design of a 1000 MWe LMFBR are given. Data and information needs for the design work are tabulated. Programs for systems and component design are described; program costs are estimated. A value analysis for the LMFBR development is detailed. (M.L.S.)

5515 (WARD-2000-97) 1000 MWe LMFBR FOLLOW-ON STUDY. TASKS II AND III. WESTINGHOUSE CONCEPTUAL DESIGN REPORT. Shufelt, C. E. (ed.) (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr 1969. Contract 31-109-38-2000. 900p. Dep. CFSTI.

For Argonne National Lab., Ill.

The conceptual design report for a 1000 MWe LMFBR is detailed. Sections of the report include: reactor core and vessel internals; reactor vessel; reactor shielding systems; main heat transfer systems; intermediate coolant system; steam generator system; energy conversion system; auxiliary and support systems—auxiliary cooling system, fuel handling system, sodium service system, inert cover gas system, main hot cell environmental control systems, nitrogen service system, NaK service system, plant electrical systems, manned access system, radioactive waste treatment and disposal systems, trace heating, and equipment cleanup and decontamination system; reactor plant maintenance system; control and safety systems; radiation monitoring systems; safety systems; and site and structures. Appendices include: alternate core design and trade-off evaluation; preliminary availability analysis of the 1000 MWe FBR reference plant; general availability calculation; fuel cycle cost calculations; compound doubling time calculation; breeding ratio breakdown; cycle times and load factors; sodium-water reaction problems and uncertainties; equipment requirements; cold trap design basis for sodium purification; inert cover gas system specification; NaK service system equipment requirements; and site-related environmental forces. (M.L.S.)

5516 FAST BREEDER REACTORS. Nijs, W. W. Atoomenergie Haar Toepass.; 11: 185-93(Jul-Aug 1969). (In Dutch).

The development of fast breeder reactors in various countries is surveyed, indicating the availability of fuel for this type of reactors and the specifications of the already built and planned fast breeders. The specifications for the prototype and advanced design of sodium cooled fast breeder reactors in United States, United Kingdom, France, and the Soviet Union are tabulated. In addition to the design and properties of fuel elements, the potential fuel cycles and properties of fuel elements, the potential fuel cycles and the present state of the sodium technology, and the safety aspects of these types of reactors are also examined. The features of the liquid-metal-cooled design are compared with those of the helium-gas-cooled fast breeder reactors. 11 refs. (TTT)

Kinetics and Dynamics

Refer also to abstract 5551.

5517 (TRG-Report-1808) EQUICORE: A SPACE DEPENDENT CODE TO ASSESS THE NUCLEAR AND THERMAL PERFORMANCE OF S.G.H.W. AND SIMILAR REACTORS. Bicevskis, A.; Hesse, E. W. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1969. 33p. Dep. CFSTI (U. S. Sales Only). UK 5s.

EQUICORE is a survey code written in Fortran 4 which deals with a pressure tube reactor core at equilibrium and calculates both the fuel burnup and the average RZ-power distribution with the corresponding channel coolant conditions across the core. The EQUICORE method calculates the flux field from the average properties in the core which are obtained from hydraulic and burn-up calculations in representative channels across the core, the calculating sequence proceeding in an iterative manner. Since time dependence was eliminated and a realistic core representation was achieved in two dimensions the calculation is fast and the method is suitable for investigating many alternative designs and fuel management schemes. In addition the code has the facility for calculating the variation of power and flow during a time dependent burnup of a central channel surrounded by the previously determined equilibrium core properties. The EQUICORE code is at present fully operational and was used during a design study to investigate a range of core parameters. 11 references. (auth)

5518 (WCAP-3680-22) XENON-INDUCED SPATIAL INSTABILITIES IN THREE-DIMENSIONS. Skogen, Finn B.; McFarlane, Allan F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sep 1969. Contract AT(30-1)-3680. 53p. (EURAEC-2116). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Three-dimensional diffusion theory calculations are performed to study xenon-induced spatial oscillations in large pressurized water reactor (PWR) cores. A typical core is represented and a steady-state, unperturbed condition is created, simulating normal, full-power operation. A perturbation representing the full insertion of one control rod for one hour is introduced and the subsequent behavior of the power distribution is studied. The perturbed core exhibits an identifiable X-Y oscillation which converges, and an axial oscillation which diverges. The results of the three-dimensional calculation are compared with two-dimensional calculations for selected planes in the core and with a one-dimensional axial calculation representing the average channel. (auth)

5519 (WCAP-3680-23) CONTROL OF XENON INSTABILITIES IN LARGE PRESSURIZED WATER REACTORS. Summary Report. Christie, A. M.; Hudec, W. S.; McFarlane, A. F.; O'Boyle, M. J.; Olhoeft, J. E.; Poncelet, C. G.; Skogen, F. B. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sep 1969. Contract AT(30-1)-3680. 58p. (EURAEC-2117). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Detailed analyses, both theoretical and analytical, were performed to study fully the characteristics of free-running Xe oscillations in large pressurized water reactors and to evaluate the effects of variations of individual core parameters on core stability. Included in that evaluation were such parameters as core size, fuel enrichment, power distribution, power coefficient, power density, I_2 and Xe yields, and thermal Xe absorption cross section. Strategies for controlling divergent Xe oscillations in the X-Y plane in large PWR cores were investigated using one- and two-dimensional digital simulation techniques. A three-zone core typical of the largest present-day PWR was used in the control studies. Three dimensional calculations incorporating nuclear, thermal, and hydraulic feedback effects were performed to substantiate the validity of one- and two-dimensional calculations. The predictions of the simpler models are generally consistent with the three-dimensional calculation. 7 references. (auth)

5520 ROTATING SHIM CYLINDERS IN REFLECTOR OF U-H_2O CORES. Krasin, A. K.; Levadnyi, V. A.; Kukhaev, A. L.; Kontrovskii, S. N. At. Energ. (USSR); 27: 386-91(Nov 1969). (In Russian).

The use of rotating shim cylinders arranged in the reactor reflector as control and safety system elements of the small thermal reactors was investigated. A suitable calculational method was developed. The experimental data required for the calculational method were obtained. Satisfactory agreement of calculation with experiment is noted. The calculational method can be used for design calculation efficiency of the rotating shim cylinder system, arbitrarily arranged in the reflector of a small reactor and turned at arbitrary angles. 5 references. (auth)

Cooling Systems

Refer also to abstract 4502.

5521 (EUR-4280(Vol.2)) INFORMATION MEETING ON WORK RELATING TO PRESTRESSED CONCRETE VESSELS AND THEIR ISOLATION, BRUSSELS, 7-8 NOVEMBER 1967. (European Communities, Luxembourg. Commission). 1969. 402p. (In Several Languages). (CONF-671145-(Vol.2)).

Included are 12 papers on the thermal insulation of prestressed concrete vessels for nuclear reactors. Both experimental and theoretical studies are presented on cooling systems for concrete vessels and on properties of various insulating materials. Discussed in the papers are: (1) Natural Convection in Confined Spaces; (2) Natural Convection over Plane Walls; (3) Natural Convection in a Fibrous Medium; (4) Studies of Vessel Cooling with Water and with Gas; (5) Experiments on Insulating Walls at Figaro Research Installation; (6) Insulation by Means of Honeycomb Structures of Stainless Steel; (7) Thermal Insulation Study Methods; (8) Calculational Methods for Internal Cooling Circuits; (9) Stainless Steel Thermal Insulation; (10) Glass Fiber Thermal Insulation System; (11) Thermal Insulation System Based on Diamond-Shaped Stainless Steel Cells; and (12) Insulation for High Temperature Helium-Cooled Reactors. (H.D.R.)

5522 (ORNL-TM-2780) PRELIMINARY SYSTEMS DESIGN DESCRIPTION (TITLE I DESIGN) OF THE SALT PUMP TEST STAND FOR THE MOLTEN SALT BREEDER EXPERIMENT. Wilson, L. V.; Grindell, A. G. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 107p. Dep. CFSTI.

A stand is required to test the salt pumps for the Molten Salt Breeder Experiment (MSBE). It will be designed to accommodate pumps having capacities up to 8000 gpm and operating with salts of specific gravities to 3.5 at discharge pressures to 400 psig and temperatures to 1300°F normally and to 1400°F for short periods of time. Both the drive motor electrical supply and the heat removal system external to the loop will be designed for 1500 hp heat removal capability. Preventive measures to protect personnel and equipment from the deleterious effects of a salt leak will be taken. The preliminary system design description and the Title I design calculations of the test stand are presented. Descriptions, functions, and design requirements for components and subsystems are provided. The principles of operation of the test stand, the safety precautions, and the maintenance philosophy are discussed. The quality assurance program plan is being prepared. (auth)

5523 (ZJE-54) PROPAGATION OF PRESSURE WAVES IN A CYLINDRICAL WAVE-GUIDE OF FINITE LENGTH. Pecinka, L. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). Oct 1969. 18p. Dep. CFSTI (U. S. Sales Only).

Analysis of pressure conditions in a cylindrical wave-guide with respect to the primary piping of a gas-cooled reactor is presented. Propagation of pressure disturbances in the wave-guide is analyzed. Frequency and amplitude of pressure waves caused by the blower are determined. Eigenfrequencies and nodal points in the wave-guide are calculated. The conditions for avoiding resonance frequencies are described. 7 references. (auth)

5524 STRUCTURE COMPONENTS OF SODIUM LOOPS. Schwarz, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 12: 281-7(Sept 1969). (In German).

A review of liquid sodium cooled reactor cooling system component development, operation, and maintenance is presented. Pumps and heat exchangers are described. 25 references. (auth)

5525 IMPROVEMENTS IN NUCLEAR REACTORS. Hannerz, Kare; Skygge, Carl Goesta; Sundqvist, Cnut (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,171,856. 26 Nov 1969. Priority date 31 Mar 1966, Sweden.

HEAT TRANSFER SYSTEMS—boiling reactor, use of overhead jet pumps in
PUMPS—use of overhead jet, in boiling reactor cooling system
REACTORS, BOILING—cooling system of, use of overhead jet pumps in (D.C.C.)

5526 USE OF A GAS AT HIGH PRESSURE IN THE INTERMEDIATE CIRCUIT OF A FAST REACTOR. Bielli, Ugo; Giambelli, Giancarlo (Politecnico, Milan). Termotecnica (Milan); 23: 438-42(Sep 1969). (In Italian).

The use of helium instead of liquid Na in the intermediate circuit of a fast reactor is considered. The advantages a gas may give in dealing with safety problems are discussed and an evaluation is made of the evaporator-exchanger surfaces variations following from the substitution of Na by helium. The use of high pressure helium from this view point is profitable. 2 references. (auth)

Fuels

Refer also to abstracts 4818, 4828, and 4855.

5527 (ANL-7586) BEMOD: A CODE FOR THE LIFETIME OF METALLIC FUEL ELEMENTS. Jankus, V. Z. (Argonne National Lab., Ill.). Jul 1969. Contract W-31-109-eng-38. 46p. Dep. CFSTI.

A computer code (BEMOD) has been developed to describe the behavior of reactor fuel elements during irradiation. BEMOD calculates stresses and strains of a cylindrical Na-bonded metallic fuel element at several axially distributed points along the element. Growth of the fuel during irradiation is described as the sum of inexorable swelling and compressible breakaway swelling. Inexorable swelling is a linear function of the fraction of fission gas released. The fuel rod is only allowed to expand radially, and fission-gas release is taken to be an empirical function of the fuel expansion only. The pressure acting upon the cladding is either the plenum pressure or the pressure exerted by the fuel in direct contact with the cladding. No friction or trapping of bond sodium between the fuel and cladding is allowed. The creep of the cladding is described by an average temperature and an average hoop stress, and irradiation growth of the cladding is neglected. The behavior of the fuel element is described under steady-state conditions, but the code also calculates the stresses and estimates strain changes for an accidental overpower or flow-coast-down. As an application, the BEMOD code is used to calculate the influence of several design parameters on cladding strain as a function of burnup of the EBR-II driver fuel. These variables are plenum volume, linear power, smear density, gas release, and cladding strength. 24 references. (auth)

5528 (JAERI-1182) RESEARCH AND DEVELOPMENT OF THE FUEL ASSEMBLY FOR JAPAN EXPERIMENTAL FAST REACTOR (FOX-PROGRAM). (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Apr. 1969. 72p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

The preliminary design of the Japan Experimental Fast Reactor (JEFR) was completed in 1964. Following each evolution in the JEFR design, fuel assemblies were fabricated and tested under the Fast OXide Fuel Assembly (FOX) program. The fuel assembly fabrication and testing experiences under the FOX program are summarized. Characteristic tests included hydraulic flow tests, materials strength tests, sodium soaking tests, and mechanical properties measurements. (H.D.R.)

5529 ON-POWER LIQUID COOLED BOTTOM FUELLED NUCLEAR REACTOR. Mackay, I. N. (to Canadian General Electric Co. Ltd.). Canadian Patent 818,144. 15 Jul 1969.

A method of on-power fueling for a heavy-water moderated nuclear reactor having a vertical calandria and short fuel bundles in the fuel channels of the core is described. The pressurized coolant flows downward and assists gravity when fuel bundles are to be removed. The single fueling machine containing a magazine operates underneath the calandria receiving bundles by locking on to the fuel channel end without loss of pressure, and inserting new fuel bundles or shuffling partly spent bundles as required. Associated pumps, heat exchangers and partial drainage of moderator to avoid "poison-out" are also described. Economy of capital cost is effected by reduction in reactor containment dimensions and the use of only one fueling machine. (F.S.A.)

5530 METHOD OF CONTAINING AND WITHDRAWING FUEL FROM THE FUEL SPACE IN A NUCLEAR REACTOR. Grant, Walter Lawrence (to Atomic Energy Board). U. S. Patent 3,481,831. 2 Dec 1969. Priority date 11 Jun 1964, South Africa.

A method of removing fuel from the fuel space of a fuel element of a nuclear reactor is described which consists of melting a plug of frozen coolant supporting the fuel in the fuel space and also removing only some fuel at a time by the use of more than one frozen plug at different elevations. (Offic. Gaz.)

5531 FUEL ELEMENT ASSEMBLY FOR A NUCLEAR REACTOR. Grant, W. L. (to Atomic Energy Board). Canadian Patent 818,150. 15 Jul 1969. Priority date 11 Jun 1964, South Africa.

The fuel assembly described is especially adapted for any type of granular, fissionable fuel cooled with liquid metal or gas. Replaceable units and a heat exchanger are characteristic of the device. The tubular fuel container has coolant ducts inside disposed parallel to and in the vicinity of the longitudinal axis of the container. Granules are packed in the fuel space around the ducts with loading and unloading means provided at opposite ends and adapted to permit the granular nuclear fuel to be supplied or withdrawn from the fuel space when desired. Voids will occur between the granules to permit coolant flow. Clad or unclad granules may be used. Such an assembly permits supply of fresh fuel and the withdrawal of spent fuel during reactor operation at full load through oppositely situated fuel supply and withdrawal means. Provision is made for controlling flow of liquid metal coolant by freezing a plug in the supply line when it is desirable. (F.S.A.)

5532 HEAT INSULATION SYSTEM IN A REACTOR HAVING ZIRCONIUM ALLOY PRESSURE TUBES. Montagnani, Mario; Farfaletti-Casali, Flaviano (to European Atomic Energy Community). British Patent 1,172,721. 3 Dec 1969. Priority date 31 Mar 1966, Italy.

GRAPHITE—use for thermal insulation of zirconium alloy pressure tubes
REACTORS, GAS-COOLED—pressure tubes of, thermal insulation for zirconium alloy
REACTORS, ORGANIC-COOLED—pressure tubes of, thermal insulation for zirconium alloy
REACTORS, WATER-COOLED—pressure tubes of, thermal insulation for zirconium alloy
THERMAL INSULATION—pressure tube, description of zirconium alloy (D.C.C.)

Operation and Economics

5533 (NP-18081) IMPORTANCE, PLANNING, DEVELOPMENT, ECONOMIC FEASIBILITY, AND USE OF NUCLEAR ENERGY FOR UNDERDEVELOPED COUNTRIES WITH A SPECIAL REFERENCE TO PAKISTAN. Inam-Ur-Rahman (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). 1968. 506p.

Thesis.

Some problems of economic growth are discussed for various underdeveloped regions of the world. Special emphasis is given to the role of energy in development. Japan is taken as a model of development for most of the underdeveloped countries. Distribution of fossil and nuclear fuel resources in various regions of the world is discussed. Current methods of energy production are described along with their advantages and limitations. Various types of nuclear reactors available commercially are examined in detail and a brief discussion is given regarding some future reactor concepts. Management and utilization of various types of nuclear fuels presently used, or expected to be used, are considered. Economic feasibility of nuclear power reactors of all sizes is given and an effort is made to give a rough evaluation for the prospects of nuclear energy with other energy sources under different conditions. Influence of various factors such as reactor size, type, plant factor, fossil fuel costs, cost of money and nature of fuels on the competitiveness of nuclear energy are discussed. Desalination of water using nuclear energy and cost trends of desalinated water using single and dual-purpose desalination plants are described. Possible influence of recovery of chemicals from the concentrated brine on desalinated water costs is also given. Additional applications of nuclear energy for food pasteurization and sterilization, industrial production, and medical diagnosis and treatments, are discussed in some detail. Various steps and problems expected to emerge during the planning and development stages of nuclear power programs are presented: future role of nuclear energy; manpower assessment and training; siting and safety problems of nuclear reactors; problems of radioactive waste disposal; inclusion of nuclear power systems in the existing electric networks; as well as the establishment of an integrated nuclear power industry in a country are discussed in detail. A critical review is given of various types of small nuclear reactors essential for training and research purposes. Pakistan is taken as a typical example for study of future prospects of nuclear energy. A brief review is given of the country as well as its primary sources of energy. The existing and expected electrical energy sources are compared with the expected energy requirements in the future. All other applications of nuclear energy are also discussed in various regions of East as well as West Pakistan. A brief review is given of the future of nuclear energy in other countries. (auth)

Safety and Siting

5534 (CEA-Bib-164) NUCLEAR ENERGY: ACCIDENTS AND INCIDENTS. Sutra-Fourcade, Yves (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Oct 1969. 154p. (In French). Dep. CFSTI (U. S. Sales Only).

The known incidents and accidents which occurred in nuclear installations up to 1968 are listed. Incidents occurring during transport of radioactive materials in hospitals or private establishments and incidents which in different ways involved radioactive materials (nuclear submarines, bombers carrying nuclear warheads, bomb tests, etc.) are included. Six categories of incidents have been considered: (1) Critical incidents and power excursions of critical assemblies, nuclear reactors, and chemical processing installations; (2) Can rupture in nuclear reactors; (3) Various incidents in nuclear reactors; (4) Incidents during transport of radioactive materials; (5) Incidents during testing of nuclear devices; and (6) Other incidents. Some accidents are described in somewhat more detail. (auth)

5535 (NP-tr-1865) INVESTIGATION OF THE BLOWDOWN SIMULATION OF BOILING WATER REACTORS. PRELIMINARY TEST USING A MODEL CONTAINER MADE OF GLASS. PART I. EXPERIMENTS AT LOW PRESSURES. Kober, K. J.; Leistner, G.; Zimmermann, M. (Battelle Institut e. V., Frankfurt am Main (West Germany)). Translation of a German report. 45p.

The blowdown of a boiling water reactor was simulated at pressures up to about 30 psig using a glass vessel of 6" inside diameter and 28" and 51" inside height. A film was made of the boiling process in the vessel and the two-phase flow in the pipe which included high-speed motion pictures (framing rate up to 4000 pps). Measurements included the history of pressure and temperature inside the vessel, the static pressure inside the pipe, the blowdown time, the loss of water, and the increasing rise of the water level. The initial values of the water level and pressure inside the vessel, the height of the vessel, the inside diameter of the pipe, and the diameter of an orifice inside the pipe have been varied. 3 references. (auth)

5536 (WAPD-TM-840) FLASH-4: A FULLY IMPLICIT FORTRAN IV PROGRAM FOR THE DIGITAL SIMULATION OF TRANSIENTS IN A REACTOR PLANT. Porsching, T. A.; Murphy, J. H.; Redfield, J. A.; Davis, V. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar 1969. Contract AT(11-1)-Gen-14. 48p. Dep. CFSTI.

A numerical solution of the system of nonlinear ordinary differential equations which determine the energy, mass, and momentum in a hydraulic network is described. The equations are first locally linearized and then numerically integrated using a fully implicit, or backward difference method. 5 references. (auth)

5537 STATISTICAL FAULT ANALYSIS METHOD APPLIED TO ADVANCED GAS-COOLED REACTORS. Joksimovic, V. (Atomic Power Constructions Ltd., Sutton, Eng.). J. Brit. Nucl. Energy Soc.: 8: 275-302(Oct 1969).

The ultimate aim of statistical fault analysis is to assess total environmental hazard due to all conceivable initiating events to which a relevant nuclear power plant might be subject during its life. Descriptions are given of a statistical fault analysis method resulting in a compound model comprising fault consequence submodels, a statistical model to assess the frequency of initiating events and an overall summation model. Statistical aspects are added to the fault consequence models by allowing randomness to some of the input parameters. The fault consequence models (reactor kinetic program, can failure mechanism and activity release models) are briefly discussed, while emphasis is placed upon a description of statistical and overall summation models. To illustrate the method three representative faults were selected and analysed in detail. The three faults are medium size penetration failure, all circulator failure and a start-up fault. Results, and comments on the way they can be interpreted, are given. A sensitivity analysis of the results is given. (auth)

Research and Test Reactors

Refer also to abstracts 4409, 4511, and 4737.

5538 (AECL-3416) INTEGRAL MEASUREMENTS FOR 28-ELEMENT UO$_2$ ASSEMBLIES WITH AIR, H$_2$O, AND AIR–H$_2$O MIXTURE COOLANTS. Mehta, S. L.; Serdula, K. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jul 1969. 35p. Dep. CFSTI (U. S. Sales Only). CAN $1.00.

Detailed integral measurements were made for heavy water moderated lattices of 28-element UO$_2$ clusters at a triangular pitch of 30 cm. Fast fission ratios, δ, initial conversion ratios, γ_0, and radial cell fine structure measurements were made with three coolants; H$_2$O of densities 1.0 and 0.41 g cm^{-3} and air. Westcott spectrum parameters, r and T_n, were measured with H$_2$O coolant of densities 1.0 and 0.41 g cm^{-3}. Experimental values of δ, γ_0, r and T_n, and radial cell fine structure measurements are compared with the values predicted by the Chalk River two-group lattice recipe code LATREP. 13 references. (auth)

5539 (ANL-7483) ARGONNE ADVANCED RESEARCH REACTOR CRITICAL EXPERIMENTS. Plumlee, K. E.; Daughtry, J. W.; Johnson, T. W.; Robinson, W. R.; Schultz, R. A.; Stanford, G. S. (Argonne National Lab., Ill.). Feb 1969. Contract W-31-109-eng-38. 162p. Dep. CFSTI.

Critical experiments were performed to assist in the design of a high-performance, stainless steel-clad UO$_2$–H$_2$O core, containing about 60 kg of highly enriched uranium, for the Argonne Advanced Research Reactor. Measurements reported include neutron flux and power distributions, critical loadings, flux levels in irradiation facilities and beam tubes, control-blade calibrations, worths of voids and of various neutron-absorbing materials, and temperature coefficients. Some of the pertinent data on neutron spectrum and temperature, prompt-neutron lifetime, and the distribution of gamma radiation heating (which was measured by thermoluminescent dosimetry) are also given. Measurements made in the range of zero to 300 W in power level were in good agreement with calculations of flux and power ratios for the configurations assembled. Thus these data extrapolated to 10^{16} peak thermal flux at a reactor power of 240 MW. However, the flux per unit power was estimated to about 15% lower in the design system, which differed slightly from the critical assembly. (auth)

5540 (BNWL-993) RANGE OF ALLOWABLE OPERATING CONDITIONS FOR FFTF CLOSED LOOPS. Koreis, D. L.; Leach, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 43p. Dep. CFSTI.

The testing capability of the closed loop system for FFTF (Fast Flux Test Facility) is analyzed. The closed loop system consists of an in-reactor tube, a primary heat transport system used to transfer heat from the irradiation experiment to the Na coolant, and a secondary heat transport system for receiving and dumping heat from the primary system to the atmosphere. 5 references. (auth)

5541 (BNWL-1143) ESTABLISHMENT OF PRELIMINARY REQUIREMENTS FOR FFTF COVER GAS PURITY. Maffei, H. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

Preliminary FFTF cover gas impurity requirements for CH$_4$ and CO have been determined. The requirements are based on the reaction rates of the impurities with molten Na for various coolant temperatures assuming that all of the C introduced into the system will eventually carburize the stainless steel fuel cladding. Kinetic reaction rates of CH$_4$ and CO with Na at various temperatures have been determined and are presented. Recommendations have also been made for minimum oxygen concentration for the N$_2$ cover gas blanket system. 14 references. (auth)

5542 (BNWL-1197) FTR SHIELD DESIGN CROSS SECTIONS: A PARTIAL EVALUATION. Marr, D. R.; Zimmerman, M. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

Measured neutron transmission spectra for several thicknesses of Fe, Ni, and stainless steel are compared to transport calculations using two cross section sets: the DLC-2 99-group set from ENDF/B made available by the Radiation Shielding Information Center and the locally generated 31-group HOMSET set used in the conceptual design of the FTR shields. 6 references. (auth)

5543 (BNWL-1201) RELIABILITY ANALYSIS OF THE FFTF CONCEPTUAL PLANT PROTECTION SYSTEM. Monteith, O. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 68p. Dep. CFSTI.

The Plant Protection System is a combination of several instrumentation subsystems that monitor various parameters and functions in the FFTF. The system provides components, mechanisms, and electrical circuits to implement automatic shutdown of the reactor and actuation of containment. The reliability analysis includes unavailability studies for each parameter subsystem. Results of the study indicate that the instrument sensors and signal conditioning electronics are the major contributors to subsystem unavailability. (H.D.R.)

5544 (CISE-R-101) URANIUM METAL-HEAVY WATER LATTICES: A GENERAL SURVEY. Topical Report No. 3. Bonalumi, R.; Zorzoli, G. B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept. 1964. Contract 005-63-7-NTRI. 226p. Dep. CFSTI (U. S. Sales Only).

A critical survey of the world-wide literature about experiments on natural uranium metal fuelled, heavy water moderated lattices is presented. An effort of interpreting the experimental data on a sound theoretical basis is also included. The measurement (and theoretical prediction) of material bucklings, especially for lattice configurations typically arising in the design of power reactors, is described in view of the assessment of a proper formulation of the reactor physics problems occurring in the CISE fog cooled reactor project. Attention has also been paid to the most reliable measurements of detailed cell parameters (regarding fast fission, resonance escape, thermal fine flux distribution, etc.), in order for a detailed check of the theories used. 64 references. (auth)

5545 (CISE-R-102) THE DESIGN OF A SMALL ASSEMBLY FOR HEAVY WATER LATTICE MEASUREMENTS. Topical Report No. 4. Accinni, F.; Palazzi, F.; Parmeggiani, A.; Zorzoli, G. B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct. 1964. 88p. Dep. CFSTI (U. S. Sales Only).

The design of a small subcritical assembly, which is to be used for cell parameter and fine flux measurements, is described. Use of the neutron beam tubes as neutron sources is discussed; mathematical expressions for the fast and thermal neutron fluxes are derived. These theoretical models are evaluated numerically. Detailed descriptions of single components of the critical assembly are given; results of activation calculations for the structural members of the assembly are discussed. (M.L.S.)

5546 (KAPL-P-3847) STATIC MEASUREMENTS PREPARATORY TO SPACE-TIME KINETICS EXPERIMENTS IN THE SHA. Rydin, R. A.; Burke, J.; Feiner, F.; Seemann, K. W.; Stacey, W. M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1969]. Contract W-31-109-eng-52. 28p. (CONF-691102-6). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

A series of clean reactor kinetics experiments on loosely coupled cores has been planned for the Solid Homogeneous Assembly. A static analysis of the initial experimental configuration was performed using a three-dimensional synthesis diffusion theory model constructed of two-dimensional X-Y trial functions. For this model, cross sections plus spectrum and transport theory corrections were calculated with zero- and one-dimensional multigroup transport theory codes, while leakages were estimated from two-dimensional few-group RZ diffusion theory calculations. The resulting model correctly predicted the critical core eigenvalue, and good agreement was obtained between a series of measured and calculated foil traverses. 10 references. (auth)

5547 (KFK-844) INTERPRETATION OF DOPPLER TEST MEASUREMENT IN FAST CRITICAL NULL ENERGIE FACILITY. Fischer, E. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). May 1969. 82p. (In German). (EUR-3980). Dep. CFSTI (U. S. Sales Only).

Application of perturbation theory to the analysis of Doppler-sample measurements made in zero-power assemblies is detailed. The multigroup integral transport equation is formulated. The perturbation theory solution to the equations describing the heated sample measurements is derived; the recursion formulae for the iterative evaluation of the integrals are given. Analytical methods used in processing the data from the Doppler samples are discussed; the pertinent equations are formulated. Effects of the heating of the Doppler samples are evaluated. A detailed analysis of the theory of the Doppler coefficient for fast reactors is given. Results of calculations and analyses are shown graphically; these results are compared with ZPR measurements of a similar nature. 35 references. (M.L.S.)

5548 (LA-4273) SAFETY ANALYSIS FOR THE LOS ALAMOS CRITICAL-ASSEMBLY FACILITY. Geer, W. U.; Koontz, P. G.; Orndoff, J. D.; Paxton, H. C. (Los Alamos Scientific Lab., N. Mex.). 6 May 1969. Contract W-7405-eng-36. 30p. Dep. CFSTI.

The critical assembly facility consists of three independent assembly buildings (called Kivas) in which assemblies are operated remotely from three separate but grouped control rooms approximately one-quarter mile from the Kivas. The facility, typical critical assemblies studied, and operating procedures are described. Accident experience at the site is reviewed, and safety provisions are discussed. (H.D.R.)

5549 (ORNL-4058(Rev.)) TSF-SNAP REACTOR SAFETY ANALYSIS REPORT. Lewin, Joseph (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 119p. Dep. CFSTI.

The Tower Shielding Facility SNAP Reactor (TSF-SNAP) is a small NaK-cooled reactor of the SNAP-10A and SNAP-2 type that has been modified for use in shielding experiments. It is capable of operation at 10 kW at 716°F NaK outlet temperature, but is not temperature limited up to 800°F. The reactor will be attached to a positioning device constructed specifically for its use and independent of the towers and hoisting equipment used to position the TSR-II. The design of the reactor and its controls and the siting of the facility are such that normal operation for experiments, as proposed, will not involve radiation levels that are hazardous to the general public. The unique shutdown mechanism inherent in the fuel, hydrogen evolution in a nuclear excursion situation, removes reactivity and disassembles the core before any possibility of fuel melting can arise. The consequences of the maximum credible accident will not involve any unacceptable hazard to the public or to the rest of the Oak Ridge National Laboratory. 37 references. (auth)

5550 (TRG-Report-1896) CALCULATION OF EFFECTIVE MULTIPLICATION FACTORS IN D.M.T.R. WITH BORON LOADING IN FUEL ELEMENTS. Scott, J. M. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). 8 Jul 1969. 27p. Dep. CFSTI (U. S. Sales Only). UK 4s. 6d.

A method of calculation is described which allows examination of the change in K_{eff} with change in the variables. The introduction of ^{10}B for burnable reactivity control is considered and some preliminary experimental results are given. Changes in the operational control suggested by the calculations, and by a change in the flux detection system, are proposed to improve the constancy of the flux distribution during operation. (UK)

5551 SELF-LIMITING POWER EXCURSION CHARACTERISTICS OF LIGHT WATER REACTOR. III. INSTRUMENTATION FOR HTR-PULSE OPERATION. Kato, Hidemasa (Hitachi Ltd., Kawasaki, Japan); Imai, Munemaro; Yamada, Shuji; Inoue, Kiyoshi; Iizuka, Tomio. J. Nucl. Sci. Technol. (Tokyo); 6: 637-45(Nov 1969).

The Hitachi Training Reactor (HTR) provided with pulse operation capability was utilized for an experimental study on the excursion characteristics of light water reactors. Measurements were performed on reactor power, reactor period, released energy, fuel temperature, fuel cladding strain, pressure in water channel and water activities. The reliability of the instruments and devices employed was confirmed to be satisfactory through pulse operation tests repeated 300 times, with inserted reactivities up to 1.50$, with reactor periods down to 15 msec, and hot spot fuel temperatures up to 1,300°C. A description is also given of the instrumentation for the measurements and reactor operation. 5 references. (auth)

5552 SIMULATION OF EARTHQUAKE VIBRATION EFFECTS ON A REACTOR FUEL ELEMENT. Rudman, R. L.; Smith, C. B. (Univ. of California, Los Angeles). J. Nucl. Sci. Technol. (Tokyo); 6: 622-36(Nov 1969).

A UCLA reactor fuel element was subjected to forced vibration tests to determine if vibration-induced changes in the moderator-coolant channel width could cause reactor power fluctuations during an earthquake. The response of the fuel element was monitored by foil-strain gages while the element was vibrated in water. At the natural frequency of the fuel element (11.1) cps, an average coolant channel width increase of 0.0009 in. was observed. We estimate that fuel vibrations with this amplitude could cause a maximum power change of 2.8% in the UCLA reactor. Test conclusions are presented. 10 references. (auth)

5553 IN-CORE RADIATION DETECTOR FOR MONITORING PULSED REACTOR EXCURSIONS. Todt, W. H. (Westinghouse Electric Corp., Elmira, N. Y.). J. Brit. Nucl. Energy Soc.: 8: 320-4(Oct 1969).

An in-core radiation detector was developed to measure intense radiation levels present in pulsing reactor cores. Test results are shown for Triga and Pulstar excursions with peak power levels of 150 and 1000 MW, respectively. Life data indicate no deterioration in detector characteristics after more than 800 Triga pulses. (auth)

Rocket and Space Reactors

5554 (LA-3747) GAMMA DOSE-RATE MEASUREMENTS ON THE PHOEBUS 1B REACTOR. Ahlquist, A. John (Los Alamos Scientific Lab., N. Mex.). Jul 1968. Contract W-7405-eng-36. 6p. Dep. CFSTI.

Gamma dose-rate measurements of the four nuclear tests of the Phoebus 1B reactor tested in 1967 are presented. This was the first reactor to utilize a 360° open-well shield. Dose rates from previously tested unshielded Rover reactors of the Kiwi-Phoebus 1 size were approximately 35/min-MW at 60 ft. For the shielded Phoebus 1B reactor, the dose rate at 60 ft dropped to about 2.1R/Min-MW. 9 references. (auth)

5555 (LA-4166) FISSIONING NEUTRON FLUENCE DISTRIBUTIONS IN THE PHOEBUS 1B FACILITY SHIELD. Watson, Clayton W. (Los Alamos Scientific Lab., N. Mex.). Feb. 1968. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Axial distributions of ^{235}U fissioning neutron fluences were measured at four radial positions in the Phoebus 1B facility shield; radial distributions were measured at two axial positions (opposite the core center and across the shield top). A large anomalous peaking in the axial distributions was found at the shield upper end for radial distances into the shield greater than ~8 to 12 in. This was also manifested in the radial distribution across the shield top. Axial and radial distributions of absorption rates in the shield were available from early Monte Carlo neutron heating calculations which guided the shield design. These agreed relatively well with the measured fissioning fluence distributions, although the absorption distributions and the fissioning fluence distributions were not directly comparable, and the as-calculated and as-measured reactor-shield models were different. The experimental radial distributions through the shield opposite the core center also compared relatively well. The results from a later, directly comparable Monte Carlo calculation show that the radial distribution opposite the core center was calculated very well. The axial distributions were calculated well at distances into the shield of <~10 in. and for axial positions of <~100 in. However, the calculational model appears too transparent in the nozzle region, leading to poorer agreement for $z > 100$ in. and radii greater than ~10 to 12 in. The shield upper-end peaking at r >~10 in. does not appear in the calculated results. The origin of this peaking is still uncertain. A smaller peak at the shield lower end produced by neutron streaming between the shield and the reactor-cart shield was reproduced in the calculated results. (auth)

5556 (N-69-36756) REFLECTOR-BASED POISON-DRUM CONTROL ON EQUAL-SIZE REACTOR CORES FUELED WITH ^{233}U AND WITH ^{235}U. Mayo, Wendell; Westfall, Robert M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. 18p. (NASA-TM-X-1883). CFSTI.

Reflector based poison drum control was marginal for a heavily loaded, long life, high temperature, fast spectrum reactor core with a length to diameter ratio of about one and using uranium-235 or uranium-233 in the nitride form. A tantalum based alloy and tungsten were used as fuel pin cladding and internal core support. Beryllium oxide and molybdenum reflectors were considered as were the number of control drums, the drum spacings, and the poison sector thickness for both reactors. A one dimensional transport theory program was used for all reactivity control calculations. (auth) (STAR)

5557 NUCLEAR REACTOR THERMIONIC POWER GENERATION APPARATUS. Wilson, V. C. (to General Electric Co.). Canadian Patent 818,147. 15 Jul 1969.

A power generation apparatus for use in a nuclear reactor is described which consists of fissionable fuel subjected to a source of neutrons and which produces a temperature in excess of 2000°K. There is a thermionic converter including a collector and an emitter with cesium vapor between them. The emitter has a layer of tungsten less than 10 mils thick. Between the two is a thickness of niobium which is conductive and has a low neutron capture cross section. (F.S.A.)

Process Heat and Desalination Reactors

5558 (ORNL-NDIC-6) INDEXED BIBLIOGRAPHY OF NUCLEAR DESALINATION LITERATURE-4. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 63p. Dep. CFSTI.

Abstracts are given for approximately 225 published articles related to the desalination of seawater. The body of the report is a copy of information stored in a computerized storage and retrieval system for the Nuclear Desalination Information Center (NDIC) at the Oak Ridge National Laboratory. The abstracts are grouped in nine categories (and repeated if they fall into more than one category). An author and a keyword index to the articles referenced is provided. The keywords, which identify the content of the articles, were chosen from a thesaurus developed by NDIC. (auth)

Reactor Theory

5559 (LA-4225) THE DATA OF NUCLEAR REACTOR PHYSICS, 1967-1968. A Bibliography. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). Sept. 17, 1969. Contract W-7405-eng-36. 90p. Dep. CFSTI.

This bibliography is a continuation of LA-3740-MS. Nuclear Science Abstracts for 1967 and 1968 have been searched and the pertinent abstracts arranged in the following order: (I) Critical Experiments, Reasonably Homogeneous; (II) Critical Experiments, Lattices; (III) Reactivity Measurements; (IV) Neutron Flux Spectra; (V) Neutron Cross Sections; and (VI) Laboratory Summary Reports and Miscellaneous. Within each section the abstracts are grouped first by year of appearance in Nuclear Science Abstracts and then alphabetically by first author (or corporate author if no individual author is given). (auth)

Kinetics

Refer also to abstracts 5519 and 5571.

5560 (CISE-R-111) THEORETICAL DETERMINATION OF THERMAL AND RESONANCE ABSORPTION OF THE ^{235}U AND ^{239}Pu LOW CROSS SECTION FISSION PRODUCTS AS A FUNCTION OF FUEL IRRADIATION. Topical Report No. 7. Bruschi, C.; Pierini, G.; Rubbia, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). Mar 1964. 30p. Dep. CFSTI (U. S. Sales Only).

The derivation is given of some simple explicit formulae useful in calculating the low cross section fission product thermal and epithermal absorption parameters as a function of neutron irradiation, when fuel concentration, neutron temperature and epithermal to thermal ratio are known. Nephew's pseudoelements are used to fit the fission product aggregate properties, whereas Nephew's equations are given in a more general form; a comparison with experience gives satisfactory results. (auth)

5561 (CISE-R-148) ETA BETA: A LONG-TERM REACTIVITY CALCULATION PROGRAM IN THE ONE-DIMENSIONAL TWO-GROUP DIFFUSION APPROXIMATION. Topical Report No. 4. Bonalumi, R.; Bruschi, C.; Colonelli, A.; Daneri, A.; Gianolio, L.; Giorcelli, M.; Pierini, G.; Rubbia, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). June 1965. 108p. Dep. CFSTI (U. S. Sales Only).

The digital program ETA BETA, devised for preliminary studies on the long term behavior of thermal nuclear reactors, is described. The ETA BETA program deals essentially with one-dimension, two-group diffusion equations in cylindrical geometry, while a constant and uniform axial buckling accounts for the axial losses of neutrons. The reactor core is divided into a finite number of regions, and the time evolution of their properties is calculated by considering region averaged fluxes at discrete values of the time variable. Iterations on Xe concentration and coolant density are performed, making allowance for linear variations in all of the two-group macroscopic coefficients produced by control poison variations. Thermal neutron temperatures and cell parameters are recalculated for each region at each coolant density iteration and at each change of fuel properties with irradiation. A two-zone model is assumed for the cell calculations, which are performed in a three energy group formalism. The two-group coefficients follow when the two epithermal groups are collapsed together. Input-output format is described; a sample problem is included. (auth)

5562 (CISE-R-149) RIVV: AN ANALYTICAL CODE SOLVING THE ONE-DIMENSION TWO-GROUP DIFFUSION PROBLEM IN MULTI-REGION REACTORS. Topical Report No. 5. Bruschi, C.; Colonelli, A.; Daneri, A.; Foresti, G.; Pierini, G.; Rubbia, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). July 1965. 46p. Dep. CFSTI (U. S. Sales Only).

A digital code is presented which solves the flux distribution in a multiregion one-dimensional reflected reactor by the two-group diffusion approximation. The input data preparation is explained, and the Fortran statements are given. A brief discussion about the numerical problems encountered in setting up the code is also given. (auth)

5563 (CISE-R-150) AN ANALYTICAL METHOD FOR SOLVING A SYSTEM OF HELMHOLTZ EQUATIONS DERIVING FROM NEUTRON DIFFUSION PROBLEMS IN MULTI-REGION REACTORS (REVISED EDITION). Topical Report No. 6. Bruschi, C.; Pierini, G.; Rubbia, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1966. 36p. Dep. CFSTI (U. S. Sales Only).

An analytical method is described which solves the one-dimension multi-region few-group Helmholtz equation. The method has the property of relating the vector solution on a given surface with its gradient on the same surface. Moreover, the criticality search for the fundamental eigen-value can be performed allowing for the variation of all the macroscopic coefficients with respect to the control parameter, the only restriction being a monotonic dependence on it for each coefficient. The numerical experience in solving one-dimension multiregion few-group equations on the IBM 7090 digital computer; in particular the numerical stability of the method has been tested experimentally for a wide set of problems when applied to the multiregion two-group neutron diffusion. (auth)

5564 (EURFNR-702) MEASUREMENT AND CALCULATION OF THE REACTIVITY WORTH OF SAMPLES IN A FAST HETEROGENEOUS ZERO POWER REACTOR. Oosterkamp, W. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Sep 1969. 48p. (EUR-4309; KFK-1036). Dep. CFSTI (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

Thesis. Submitted to Technische Hogeschool, Eindhoven, Netherlands.

A method is developed to account for sample size and reactor environmental effects of reactivity worth experiments in heterogeneous zero-power reactors. The method is based on a perturbation expression of integral transport theory in the multigroup collision probability formulation. The method accounts for space-dependent resonance self-shielding. A pile-oscillator element is described that only slightly perturbs the slab geometry of the reactor. The experiments can therefore be interpreted with a one-dimensional model. The inverse kinetics method is extended to account for periodically moving fuel. Theory and experimental equipment have been tested in a series of measurements in SNEAK. The theory and the results of the perturbation expression of diffusion theory are compared for these experiments. 38 references. (auth)

5565 (WAPD-TM-878) MONTE CARLO EIGENFUNCTION ITERATION STRATEGIES THAT ARE AND ARE NOT FAIR GAMES (LWBR DEVELOPMENT PROGRAM). Gast, R. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1969. Contract AT(11-1)-Gen-14. 36p. Dep. CFSTI.

The RECAP-5 eigenfunction iteration strategy is proved to be a fair game for any problem for which the analytic neutron transport equation possesses a unique fundamental mode eigenfunction. This strategy is designed so that initial iterations, which do not represent a converged source, are combined equally with other iterations to produce results more accurate than if these initial iterations were omitted. The stragegy is in two parts. The gross shape portion employs a correction source per gross volume per iteration such that if these correction sources are accumulated, the procedure will closely resemble the analytic power method. The detailed shape portion employs a sampling procedure which obtains starting sites within a gross volume from the accumulation of all progeny sites within that volume. Both parts of the strategy are used simultaneously and are non-Markovian. Examples are given of iteration strategies, i.e., certain analogs of the analytic power method, which are not fair games. (auth)

5566 GENERAL SOLUTION OF KINETIC EQUATIONS OF A DOUBLE COUPLED REACTOR SYSTEM. Vorob'ev, E. D.; Kalashnikov, E. G. Uch. Zap. Ul'yanovsk. Gos. Pedagog. Inst., No. 9, 44-50(1966). (In Russian).

An attempt was made of finding a solution for kinetic equations of double coupled reactor system using the method of Ziya Akkasu applied for analysis of kinetics of one-region reactor. Several examples are given using the step function, linear function, and sinusoidal function. 4 references. (R.V.J.)

5567 RELATIONSHIP BETWEEN COUPLED REACTOR SYSTEM PARAMETERS AND DETAILED NEUTRON FLUX DISTRIBUTION. Vorob'ev, E. D.; Kalashnikov, E. G. Uch. Zap. Ul'yanovsk. Gos. Pedagog. Inst., No. 9, 33-7(1966). (In Russian).

A two-group equation system was written for an assembly with breeding neutron material. The perturbation in the assembly was initiated by small variations of one or several parameters and simultaneous convergence of the given assembly with certain other critical assemblies. The parameters may have various proportions; however, the system should never approach a state of instantaneous criticality. The interactions, in general, take place with thermal or fast neutrons with the ratio of thermal and fast neutrons incoming from the second assembly depending on the type of the media separating the assemblies and on the distance between the assemblies. 3 references. (R.V.J.)

5568 SOLUTION OF KINETIC EQUATIONS OF A DOUBLE COUPLED REACTOR SYSTEM FOR A REACTIVITY. Vorob'ev, E. D.; Kalashnikov, E. G. Uch. Zap. Ul'yanovsk. Gos. Pedagog. Inst., No. 9, 38-43(1966). (In Russian).

Analytical equations obtained previously were used for obtaining a precise solution for the kinetic equations of double coupled reactor system for a sudden-jump reactivity. The solution was confined to the solution of reactivity introduced only into one assembly. 2 references. (R.V.J.)

5569 APPROXIMATE SOLUTION OF ONE-POINT REACTOR KINETIC EQUATIONS FOR ARBITRARY REACTIVITIES. Amano, Fumio (Electrotechnical Lab., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 6: 646-56(Nov 1969).

A very simple formulation of the reactor kinetic equation for arbitrary reactivity variations which can be solved analytically is described. The method of matched asymptotic expansions, which is a generalization of methods used in boundary-layer analysis, is employed to estimate the neutron density and the reactor period for ramp and periodic inputs. The small amounts of error arising in individual cases are analyzed quantitatively by comparison with results obtained from difference approximation (Runge-Kutta-Merson method). The validity of the zero-prompt-lifetime approximation and the stability condition for periodic inputs are also discussed. 15 references. (auth)

Dynamics

5570 REGIME OF XENON-INDUCED OSCILLATIONS RISE. Gushchin, G. P.; Postnikov, I. S.; Sabaev, E. F. At. Energ. (USSR); 27: 402-6(Nov 1969). (In Russian).

A regime of the xenon-induced oscillations rise in nuclear thermal reactors is studied on the basis of simplified nonlinear mathematical model with the harmonic interaction neglected. It is shown that the boundary of the linear stability region of the nuclear thermal reactor with the xenon reactivity feedback can be dangerous. Numerical results for the regimes of the xenon-induced oscillations rise are given. 10 references. (auth)

Experimental Applications

Refer also to abstracts 5517, 5520, 5527, 5536, and 5544.

Reactor Components, Fuels, and Accessories

Refer also to abstracts 4354, 4403, 4406, 4414, 4504, 4710, 4717, 4725, 4769, 4771, 4792, 4816, 4819, 4827, 4829, 4833, 4837, 4838, 4841, 4854, 4856, and 4857.

5571 (IN-1346) RELEASE OF NOBLE GASES FROM UO$_2$ FUEL RODS. Yuill, W. A.; Baston, V. F.; McFadden, J. H. (Idaho Nuclear Corp., Idaho Falls). Nov 1969. Contract AT-(10-1)-1230. 22p. Dep. CFSTI.

An analytical function has been developed for correlating fission gas capsule release data. This function, derived through a thermodynamic approach employing Gibbs-free-energy relationships, provides an excellent correlation of the capsule release data for fuel elements during reactor operation. The thermodynamic approach demonstrates that the outer regions of the UO$_2$ fuel control fission gas release from a fuel pin during operation and that a large temperature gradient retards the escape of fission gases. The analytical function derived predicts results which are contrary to most of the currently published models, however, it is not entirely unique as is discussed. The equation for the least squares fit of the function and the operating data for a fuel pin may be used to calculate the release fraction to within a factor of two of the observed release fraction. The function also correctly predicts the relation between the decay constant, λ_i, and the release fraction, F_i. 24 references. (auth)

5572 NUCLEAR REACTOR CORE AND CONTROL ELEMENT ARRANGEMENT. Rickert, Royce J. (to Combustion Engineering Inc.). U. S. Patent 3,481,832. 2 Dec 1969. Filed 14 Apr 1967.

A nuclear reactor is described having fuel element assemblies composed of a plurality of fuel elements in which a plurality of adjacent fuel elements are removed forming a few large coolant-moderator channels through the assemblies into which large control rod fingers may be inserted. These large coolant-moderator channels are closely and relatively uniformly spaced in a repetitive array throughout the core whereby the distance between any two coolant channels will not be greater than several neutron diffusion lengths and the ratio of the maximum to average power density will be reduced. Control rod guide tubes in these coolant channels protect the control rod fingers and form a structural support for the fuel element assemblies. The large size and thus small number of control rod fingers simplifies their mounting, guiding, and shrouding and thus makes possible their uniform spacing. (Offic. Gaz.)

5573 FUEL FOR NUCLEAR REACTORS. (to Societe Belge Pour l'Industrie Nucleaire). British Patent 1,172,572. 3 Dec 1969. Priority date 7 Jun 1966, Belgium.

PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fabrication of grain shaped pressed powder, description of vibration compacted

REACTOR FUEL ELEMENTS—fabrication of plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type, description of vibration compacted

URANIUM OXIDES UO_2—PuO_2–UO_2, fabrication of grain shaped pressed powder, description of vibration compacted (D.C.C.)

GENERAL

5574 (ANL-7599) C:READ: A REENTRANT ROUTINE TO CONVERT EBCDIC DECIMAL NUMBERS TO HEXADECIMAL. Thalmayer, Conrad E. (Argonne National Lab., Ill.). Aug 1969. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

This report describes a reentrant, general-purpose routine for the Xerox Data Systems Sigma 5 or Sigma 7 computer with Floating-Point Option. C:READ converts EBCDIC decimal numbers in their normal input forms to hexadecimal numbers in the forms used in the computer. The report explains the need for the routine, describes its capabilities, presents all the information necessary for using it, and outlines its structure. The flow charts and listing are included. (auth)

5575 (LA-4246) COMPUTER STUDIES OF SOME HISTORY-DEPENDENT RANDOM PROCESSES. Beyer, W. A.; Schrandt, R. G.; Ulam, S. M. (Los Alamos Scientific Lab., N. Mex.). Jul 1969. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Various history-dependent random processes are investigated by computer and a few cases are investigated theoretically. These processes include history-dependent random walks, a combination of a birth process and a self-avoiding random walk, history-dependent randomly-generated increasing integer sequences, and randomly-generated integer sequences which might have prime-like densities. A possible random ergodic theorem for history-dependent processes is discussed. (auth)

5576 (ORNL-TM-2593) OPERATION MANUAL FOR THE UV ANALYZER, PROTOTYPE MARK II. Pitt, W. Wilson; Johnson, W. F.; Scott, C. D. (Oak Ridge National Lab., Tenn.). Aug. 1969. 17p. Dep. CFSTI.

Detailed operating instructions for a high-resolution automated analytical system that has application in clinical and research laboratories are presented. The UV Analyzer Prototype Mark II uses gradient elution anion exchange chromatography to separate the many constituents of body fluids, and a wavelength shifting recording spectrophotometer to detect and quantify those that absorb ultraviolet light. (auth)

5577 (RFP-1363) MATHEMATICAL ANALYSIS OF THE OPTOMECHANISMS LASER INTERFEROMETER. Utley, L. William (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 29 Sep 1969. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

A mathematical analysis was conducted of the laser interferometer system, Model 437L-512, distributed by OPTOmechanisms, Incorporated, of Plainview, New York. The study was done to determine the characteristics of the optical system of the interferometer. Detailed descriptions show how the movement of the corner-cube reflector in the system produces two signals with a 90° phase shift when seen through two crossed polaroid plates. (auth)

5578 (SCL-DR-69-105) SLAP: SANDIA-LIVERMORE AEROHEATING PROGRAM. Witze, P. O.; Hartley, D. L. (Sandia Labs., Livermore, Calif.). Nov 1969. Contract AT(29-1)-789. 42p. Dep. CFSTI.

The governing equations, method of solution, and user's guide are presented for the SLAP computer program. This code predicts aerodynamic heating rates to bodies of sphere-cone geometries. Considered in the solution are the effects of pressure gradients and the curved bow-shock wave. (auth)

5579 (TID-25267) DESALINATION RESEARCH AT OAK RIDGE. Research and Development Progress Report No. 468. Kraus, K. A.; Raridon, R. J.; Johnson, J. S.; Bohlmann, E. G.; Posey, F. A. (Oak Ridge National Lab., Tenn.). Aug 1969. 53p. Dep. CFSTI. GPO $0.60.

A list is presented of open literature publications issued by the ORNL Water Research Program from the start of the program through December 1968, and those items in the biennial report that were not otherwise published. The list is arranged alphabetically by first author for each year. Author and subject indexes are included. (M.C.G.)

5580 (UCRL-18721) JASON: A DIGITAL COMPUTER PROGRAM FOR THE NUMERICAL SOLUTION OF THE LINEAR POISSON EQUATION. Sackett, S.; Healey, R. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1969. Contract W-7405-eng-48. 51p. Dep. CFSTI.

This paper describes the development of a high-speed computer program for the solution of the linear Poisson equation $\underline{\nabla} \cdot (\underline{\underline{\kappa}}\underline{\nabla}\phi) + \rho = 0$, where ϕ and ρ are scalar functions of two independent variables, and $\underline{\underline{\kappa}}$ is a second rank tensor whose components are functions of two independent variables. The mathematical model is given in detail. Examples showing the application of the FORTRAN program to the solution of problems in electrostatics demonstrates its speed and accuracy. Outstanding characteristics of JASON, in addition to speed, are the following: (1) usage for both cylindrically symmetric systems and for two-dimensional Cartesian systems, (2) completely general boundary conditions (Neumann, Dirichlet), (3) generalized quadrilateral mesh, (4) utilization of algorithms which ensure continuity of ϕ across mesh lines, (5) use of block iterative methods for solution of the equations, (6) ease and simplicity of input, and (7) consideration of nonhomogeneous, anisotropic media through use of the tensor $\underline{\underline{\kappa}}$. (auth)

5581 (UCRL-50732) COMPARISON STUDY OF SIX IMPULSE GAGES USING A PULSED ELECTRON BEAM. Woodruff, L. W.; Comfort, W. J. (California Univ., Livermore. Lawrence Radiation Lab.). 20 Aug 1969. 25p. Dep. CFSTI.

Six types of impulse gages were examined experimentally by inducing splash-off in targets with a pulsed electron beam. The six types were: plastic hinge gage, VTAB, displacement gage, elastic cantilever beam gage, torsion gage, and honeycomb crush gage. Identical 2.54-cm-dia lead targets were mounted on each gage. Splash-off of the targets was induced by an electron generator that could produce electrons with energies up to 2 MeV and a maximum fluence of 25 cal/cm^2. The resulting impulse to the gages was nominally as high as 8000 dyne-sec. A high speed camera recorded the history of splash-off and the responses of the gages. These pictures illustrate several of the design problems that must be considered if one is to successfully use the gages. 40 impulse measurements were made. Generally, all of the gages operated as intended and the measured values agreed reasonably well. (auth)

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

AEC Symposium Series

BIOLOGICAL IMPLICATIONS OF THE NUCLEAR AGE

This symposium, sponsored by the Bio-Medical Division, Lawrence Radiation Laboratory, and the U. S. Atomic Energy Commission, covers a broad range of topics, such as the present and future sources and distribution of radionuclides, what criteria are used for guidance in radiation protection, and how the genetic and somatic effects of low-dose irradiation are shown in animals and man. Also discussed are the interactions that take place between radiation and other environmental agents and the repair and recovery from radiation damage. 350 pages, 100 figures, 6 by 9 in.

Contents

The Atom's Expanding Role in the Medical World

Perspectives
Objectives of Biomedical Research in Relation to Atomic Energy
Planned Applications of Peaceful Nuclear Explosives
Application of Basic Radiation Protection Criteria

Release and Distribution of Radionuclides in the Biosphere
Estimation of the Maximum Dose to Man from the Contamination of an Aquatic Ecosystem with Radionuclides
Estimation of the Maximum Dose to Man from the Fallout of Radionuclides on Agricultural Land
Radioactive Pollution of the Atmosphere
Reactor Releases of Radionuclides
United Kingdom Studies on Radioactive Materials Released in the Marine Environment

Presence and Persistence of Radionuclides; Possible Countermeasures Against Harmful Consequences of Radionuclide Contamination
Persistence of Radionuclides at Sites of Nuclear Detonations
Radionuclides in Food
Status of Remedial Measures Against Environmental Radiocontamination

Effects of Radiation in Man and Animals; Relations Among Radiation Viruses and Other Environmental Hazards; Repair of Radiation Damage
Some Biological Effects of Radiation in Relation to Other Environmental Agents
Effects of Single or Fractionated X Irradiation and of Bone-Seeking Radionuclides on Mammals: A Review
Late Effects of External Irradiations in Animals and the Prediction of Low-Dose Effects
Radiation Repair Mechanisms in Mammalian Cells
Delayed Radiation Effects Among Japanese Survivors of the Atomic Bombs
Radiation and Virus Interactions in Leukemogenesis

Available for $3.00 as CONF-690303 from

Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151